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"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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> *"To the solid ground*
> *Of Nature trusts the mind which builds for aye."*—WORDSWORTH.

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River Pollution and Fisheries.

ANGLING in the slow-running rivers of England affords recreation for an ever-increasing number of artisans and other responsible citizens of our large industrial centres. Inexpensive opportunities of health-giving open-air amusements in the limited time they have available are becoming fewer as the population increases and greater distances have to be traversed before arriving beyond the outskirts of the cities. Since it is upon the health and contentment of the city and industrial workers that the prosperity of the country has come to rest, it has become a duty of the nation to conserve the facilities for this tranquil and pleasant pastime quite as much as to conserve the more valuable salmon and trout fisheries, all of which suffer from the effects of pollution by industrial and other effluents more and more as time goes on.

With these objects in view, the Standing Committee on River Pollution was appointed in 1921, and, with the help of local sub-committees, and a growing weight of public opinion, it has already accomplished a great deal towards checking an increase in pollution, and in some cases in ameliorating the existing conditions. The problem with which the Committee is faced is not a simple one; it is not obvious how, in many cases, an industrial effluent can be rendered harmless, or sufficiently non-toxic and clear, so as not to damage life in the river or the amenities of the country-side. Every such effluent must go somewhere or the industry be dislocated; its satisfactory treatment in the space available at reasonable cost frequently provides matter for research.

An interesting problem of the moment is the satisfactory treatment and disposal of the large volume of water used for washing and transportation in the new beet-sugar factories. This wash water, besides dirt, contains organic matter in solution and suspension which, although comparatively harmless to fish life on leaving the factory, may become harmful owing to the development of toxic substances during the decomposition of the organic matter.

It is often easy enough to determine whether a river is polluted, but quite another matter to gauge the extent to which life in the river will be damaged. Fish utilise as food a large number of organisms, animals as well as plants. The larger animals, such as the fresh-water shrimp and insect larvæ, which serve as food for many species of fish, in turn feed on smaller animals and plants. In many cases the dependence of one on the other is direct and obvious: in others less so. The presence or absence of vegetation, even of the smallest forms such as diatoms, may play a considerable rôle in determining the conditions of life in a river, quite apart from their actual food value, since they afford harbourage to animals and assist in the self-purification of the water. Hence it is clearly not the direct physiological effect of a polluting effluent upon fish alone which has finally to be determined, but its effect, if any, upon some necessary link in the food-chain and upon the flora.

The need for the solution of problems such as these before satisfactory legislation can be introduced to cope with river pollution is obvious, and has been felt in countries other than England. In 1920 the Dutch Government established a central institute at the Hague for experimental work in connexion with waste waters generally, from which advice is now sought by local authorities administering the law against pollution of the canals and waterways, and by industrial associations seeking the most economical means of treating their effluents. In the United States many rivers are grossly polluted; for example, the river carrying the Chicago sewage is stated to be devoid of dissolved oxygen for a distance of twenty miles. There the question of rational legislation is beginning to attract attention, and many specific problems are presenting themselves. Since the laws of the country have allowed the rivers to be treated as a public sink, and in consequence vested interests in them as such have developed, it will doubtless be a difficult and very expensive task to cope with their purification.

In Great Britain numerous surveys of rivers have been carried out and local pollutions investigated during the last five years by Dr. E. C. Jee, the technical adviser to the Standing Committee on River Pollution, and by several scientific workers resident in various districts. Upon the results of this work, action has been taken in a number of cases and has led to the abatement of nuisances, and the fact that sources of pollution are being investigated at intervals and reported upon undoubtedly acts as a deterrent against increased pollution in other cases.

Besides this necessary survey work and investigation of local problems, a small scientific staff at the Fisheries Experimental Station, Alresford, have begun several lines of research fundamental to a proper scientific attack of many existing problems. With the final object of undertaking a complete biological survey of a river with particular reference to the effect of various pollutions upon the normal fauna and flora, methods have been evolved which aim at providing a quantitative, or, at any rate, comparable, measure of the abundance of life in different rivers or in the same river at different times of the year. Preliminary work showed that by far the greater proportion of the animal life (in the upper waters of the Itchen) lived either on the bottom or among the weeds which clothe it; ordinary dredges did not yield a representative sample. To obtain a representative sample of the smaller animals a frame with gauze bottom containing stones, etc., similar to the river bottom, was left for a week in the river, and the organisms which had migrated into it were then picked out and counted. It is anticipated that the various methods evolved will be of service in the examinations of polluted rivers, and also that results obtained will finally provide a valuable basis for comparison.

Fish found dead are frequently posted to Alresford for examination, and as our present knowledge of fish disease is fragmentary and the fish often arrive after decomposition has commenced, giving rise to symptoms which may easily be mistaken for those produced in a fresh fish by poisoning, an attempt is being made to obtain further accurate knowledge of post-mortem conditions, particularly histological changes in the gills and alimentary canal due to poisoning.

The need for investigations of a general nature is amply borne out; the Standing Committee on River Pollution in its recent report[1] states that it is "constantly faced with the lack of scientific knowledge necessary to devise a method of dealing with a particular effluent," and advocates the appointment of sufficient technical staff to elucidate, not only in the laboratory, but also by experiments at the source of pollution, the scientific questions which at present have no answer.

The future of many rivers in Great Britain is clearly in the hands of the chemist and biologist, for it is upon accurate knowledge such as they alone can obtain that any satisfactory legislation must rest. The longer the necessary efforts to tackle the pollution problem in a comprehensive manner is put off, the more difficult and the more expensive will be the task and the greater the risk of failure.

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[1] "River Pollution and Fisheries. A non-technical report on the work during 1925 of the Standing Committee on River Pollution." Ministry of Agriculture and Fisheries, London. 1926. Price 6d.

To allow the serious pollution which exists at present in some British rivers to continue more or less unchecked and to grow, which it undoubtedly will tend to do as the population and industries increase, is an evil greater than can be expressed in terms of decreased monetary value of the fisheries. Increased demands on the water supply in towns and cities as they enlarge have also to be considered. From before the time of Isaac Walton the rivers of England have been part of the nation's playground, a playground put to greater use as the population becomes denser, a heritage to preserve—unpolluted.

The Origin of Civilisation in America.

La Esfinge Indiana: antiguos y nuevos aspectos del problema de los origenes americanos. By Prof. J. Imbelloni. Pp. 399+19 plates. (Buenos Aires: Libreria "El Ateneo," 1926.) n.p.

ALTHOUGH there is no reference to W. H. Prescott in this book, its title, "The Indian Sphinx," and the author's frequent references to himself as the Oedipus who is solving the riddle, suggest that Prescott's famous book "The Conquest of Mexico," which was published in 1843, had made a stronger impression upon him than he is prepared to admit. Both in the introduction and the lengthy appendix, Prescott gave an impressive summary of the evidence which forced him to admit, although it is clear he was very reluctant to do so, "that the coincidences are sufficiently strong to authorise a belief that the civilisation of Anahuac was in some degree influenced by that of Eastern Asia." At the same time, perhaps from having read Robertson's History, he was puzzled to account for the scores of arbitrary likenesses between the customs and beliefs of ancient Mexico and Asia. Thus he wrote:

> "Was it [the pre-Columbian civilisation of Mexico] indigenous? or was it borrowed in some degree from the nations in the Eastern World? If indigenous, how are we to explain the singular coincidence with the East in institutions and opinions? If Oriental, how shall we account for the great dissimilarity in language, and for the ignorance of some of the most simple and useful arts, which, once known, it would seem scarcely possible should have been forgotten? This is the riddle of the Sphinx, which no Oedipus has yet had the ingenuity to solve."

If there were any real scientific discipline in ethnology, one might have hoped that Prescott's two difficulties having now been removed by the advancement of knowledge during the intervening eighty years (which have also added a vast accumulation of evidence in corroboration of the clear implications of the statement in "The Conquest of Mexico"), the way would be clear for the frank admission of the diffusion of culture from eastern Asia. But in ethnology emotion still counts for more than reason: or perhaps it would be more explicit to say that the Newtonian principles of inductive reasoning, by basing theories on observed facts, have not yet penetrated into the subject, which is still under the sway of the deductive methods of Descartes. For in ethnology—and Prof. Imbelloni's treatise is a conspicuous illustration of the point—the dominating principle is still to force the evidence into conformity with certain catch-phrases that are called 'natural laws,' the *idées innées* of Descartes, the *Elementargedanke* of Bastian, the universal symbols of Freud, et cetera, from which a long line of philosophers, starting with Turgot in 1751, have been striving to rescue the study of mankind and make a real science of it.

For the introduction of confusion into the fascinating problem of the origin of the pre-Columbian civilisation of America, as indeed into all ethnological doctrine, the chief blame must be attributed to Dr. William Robertson, Principal of the University of Edinburgh, whose famous "History of America" was published in 1777. He seems to have been the first to give wide currency to the Cartesian ideas that are so popular in ethnology to-day.

> "When the people of Europe unexpectedly discovered a New World, removed at a vast distance from every part of the ancient continent which was then known, and filled with inhabitants whose appearance and manners differed remarkably from the rest of the human species, the question concerning their original became naturally an object of curiosity and attention. The theories and speculations of ingenious men with respect to this subject would fill many volumes: but are often so wild and chimerical that I should offer an insult to the understanding of my readers if I attempted . . . to enumerate or refute them." After mentioning some of these speculations he adds: "though they rest upon no better foundation than the casual resemblance of some customs, or the supposed affinity between a few words in their different languages, much erudition and more zeal have been employed to little purpose, in defence of the opposite systems."

Hence, without bothering to examine the evidence, the Scottish historian fell back on the device of formulating a law. "Were we to trace back the ideas of other nations to that rude state in which history first presents them to our view, we should discover a surprising resemblance in their tenets and practices; and should be convinced that, in similar circumstances, the faculties of the human mind hold nearly the same course in their progress, and arrive at almost the same conclusions."

I have made these quotations from the work of this eighteenth-century divine because they represent the stock-in-trade of those who claim the independence of American culture to-day. Hence they shed some light upon the interesting psychological problem of why theories that are in such flagrant conflict with the evidence should continue to be respected. The explanation is provided by the history of these fallacies. Although Robertson wrote his book more than twenty-five years after Turgot (who had acquired the Newtonian discipline of reasoning from Sigorgne, his teacher of mathematics), Scotland, as Buckle pointed out in his "History of Civilisation," still remained under the influence of Descartes and the deductive method. These ethnological fallacies were floating about for another century without being taken seriously, until in 1871 Sir Edward Tylor adopted them from Adolf Bastian, the arch-enemy of biological evolution, and gave them a fashionable and attractive veneer by calling them "evolution." By this strange irony more than fifty years ago, ethnology was put into the fetters of Cartesian scholasticism. These historical facts help us to understand how such a book as "The Indian Sphinx" could have been written.

The problem of the pre-Columbian civilisation of America, with which the book deals, is of crucial importance. Not only was it responsible, as I have just indicated, for shaping ethnological theory in the past, but also at the present it is the supreme test of clear thinking. It is becoming a habit on the part of those who defend the principle of the independent development (in other words, spontaneous generation) of culture, to pretend that they do not deny the reality of diffusion. But the American problem demands a plain answer to the question whether or not any cultural influence was conveyed across the Pacific Ocean during the first ten centuries of the Christian era. Did Mexico, Central America, and Peru derive the germs of their civilisation from Cambodia and Java fifteen centuries ago, or was it a wholly indigenous creation of the Maya and pre-Inca peoples? That is the clear-cut issue.

In this large treatise the various theories, ancient and modern, that relate to the origin of American civilisation are submitted to critical examination. In the first two-thirds of the book the author pours scorn on all theories of diffusion, adopting the extreme form of Bastian's theory of psychic unity. When the resemblances between cultures in different areas seem to put too great a strain on this speculation, he falls back on the biological theory of convergence. Hence it comes as a shock to the reader when on p. 279 he throws the *Elementargedanke* overboard and becomes an out-and-out diffusionist. He has no doubt that the Quechua and Aymara languages and the culture of South America were derived from Polynesia. The magic wand that seems to have effected this wonderful transformation is the fact that the name for an 'axe' (*toki*) and the mode of fashioning the implements are essentially identical in Oceania and South America. But having convinced himself of this fact he then proceeds to discover identities in other arts, customs, beliefs, and languages, and adopts whole-heartedly the methods he has been ridiculing in the preceding 270 pages!

This admission, however, creates new difficulties for Prof. Imbelloni. If certain words in the languages of Tonga, Samoa, and Tahiti are identical with those used in Peru, much more definite affinities can be detected in the languages of Indo-China and India. The derivation of the cultures of Oceania from India is widely admitted. Hence he is committed to the linking up of pre-Columbian American culture with that of India, which in the light of recent discoveries is known to be genetically related to those of Elam, Sumer, and Egypt. These links are all now well established, as Prof. Breasted has recently pointed out.

After an incomplete survey of the discussions of the seventeenth and eighteenth centuries, more than a hundred pages are devoted to certain modern speculations regarding connexions between America and Mesopotamia by way of Siberia and Turkestan, in the course of which essays on the evolution of the horse and the geographical distribution of the grape vine are introduced. The author examines and severely criticises Posnansky's attempt to apply to the ancient American pyramids astronomical methods for estimating their age somewhat analogous to those used by Sir Norman Lockyer in the cases of Stonehenge and Egyptian temples. Posnansky's calculation for Tiahuanacos gives a date of A.D. 1200, which seems not unreasonable: but Imbelloni says it is based on a series of errors.

Prof. Imbelloni's most scathing denunciations, however, are reserved for Part iii. of his book, in which he pours ridicule on what he calls "the Manchester School" and upon the present reviewer in particular. The bulk of this criticism follows the lines with which readers of NATURE have been made familiar during the last fifteen years, in particular in the discussion of the conventionalised elephant-heads on the Copan stela (see NATURE, November 25 and December 16, 1925, and January 27, 1916; also the interludes by Dr. Forbes and Mr. Robson in August 2 and September 13, 1924). As Prof. Imbelloni is not acquainted with anything that I have written on these matters since 1922 (most of his knowledge of my work having been derived from Dr. Germain's review in *L'Anthropologie* of that year), I need only direct his attention to the full statement on the elephant-problem in my book "Elephants and Ethnologists" (1924). But Prof. Imbelloni's indignation with me would be quite excusable if I had ever expressed the preposterous views he attributes to me when he says I pretend the Mayas and Peruvians came from Egypt! The confusion of race and culture vitiates in fact a large part of this entertaining book.

Prof. Imbelloni has rendered a very useful service in emphasising the remarkable identities between certain features of Mycenæan and Mexican architecture (Plate III.), Egyptian and Peruvian balsas (Plate XI.) (of which, unaware of the various memoirs I have written on ancient shipping, he seems to think I am ignorant), the monstrous figures (Plates XIV. and XV.) with projecting tongue in Italy, Polynesia, and Mexico (and he might have added India, Indo-China, and Indonesia), the wonderful terraces of the Philippines and Peru (Plate XVI.), et cetera. But it is very surprising that such striking illustrations of identity in arbitrary detail should be used as illustrations of convergence in that part of the book which is expounding the principle of the diffusion of culture from Polynesia to America.

At the present time scarcely any two believers in 'independent development' are in agreement as to the areas which are independent the one of the other. Prof. Imbelloni's book gives a new reshuffling. To illustrate the extent of these discrepancies I might mention that on the day his book came into my hands there also arrived a work by Prof. James H. Breasted, who admits the reality of diffusion from Egypt throughout the Old World, but refuses to admit any outside influence in America. Prof. Imbelloni denies diffusion in the Old World but admits that from the Pacific to America.

If we allow the negative parts of the two views to neutralise one another and admit the cases both writers have established by positive evidence, I think we shall arrive at the truth.

G. ELLIOT SMITH.

Lignin and Lignification.

Die Chemie des Lignins. Von Dr. Walter Fuchs. Pp. xi+327. (Berlin: Julius Springer, 1926.) 18 gold marks.

THIS monograph on a subject of outstanding interest will commend itself under its sectional title to a wide circle of workers as an important and timely critical survey. The author's treatment of the matter, however, is much more comprehensive than might be inferred from the title, for it embraces the full perspective, and the work is consequently a contribution to natural history, and, beyond the phenomenal aspects of plant life, to general philosophy. The scope of the monograph, in fact, is first to set out the very considerable chemistry of lignin resulting from the investigations of some three hundred workers whose researches are critically reviewed in the text, and then to re-examine the scientific material thus accumulated, critically selected and co-ordinated by the author, in relation to the several sections of the science of botany, systematic (classification), physiology, structure and histology, to modern conceptions of the ultimate structure of the forms of matter, to the scientific technology of industry, and thus implicitly to the philosophy of the human story, intimately interrelated as it is with that of plant life and evolution.

The philosophic note is struck early in a critical discussion of the well-known methods of identifying lignin in plant tissues, and the resulting definition of "Das genuine Lignin" as distinct from the $N-1$ lignins isolated by chemical treatment, which are either synthetic derivatives or modified forms of the actual or original lignin, the degree of change associated with the reaction mechanism of the process of separation requiring to be estimated, but necessarily by a method which is inconclusive in respect of the actual relationship. It certainly leaves undefined the mode of union of lignone to cellulose in the ligno-celluloses; and the author's treatment of this problem in the later chapters will impress upon the chemist of objective mentality the obvious but much-ignored consideration that the synthetical operations of the plant in respect of its organised cell structures are not of the order of reversible reactions of his systematic text-books.

A short outline of the work in sequence of chapters is necessary to characterise more closely its scope. Chaps. i.-iii. are concerned with (1) the identification of lignin *in situ*; (2) the isolation by various methods, direct (conversion to derivatives rendered soluble) and indirect (breakdown of associated cellulose to soluble products); (3) analysis, that is, elementary composition and estimation of 'adjective' substituting groups, and a critical comparison of the numerous 'lignins' thus separated with the genuine or ideal lignin of the organism. Chaps. iv.-vii. deal with the further special chemistry of lignin: conversion to synthetical derivation involving reactions of OH, CH=CH, CO and COOH groups, esters, ethers, halogen derivatives, condensations with phenols, reactions with oxidants and hydrogenants: hydrolyses and alkali fusions.

This *exposé* of the 'pure' or rather detached chemistry of lignin, occupying the first two hundred pages, is the author's critical digest of the literature of the subject of the period 1900–1926 (January 1), a delimitation set out in the preface. It is accurate and exhaustive of the period though not of the subject matter, for the antecedent period (1875–1900) contributed quantitative methods of fundamental value as such, but of further import when interpreted as establishing the conception of 'ligno-cellulose' by contrast with a cellulose extrinsically 'encrusted' with lignone matter. Moreover, it was clearly indicated, both *a priori* and on exact data, that the prototypes of the ligno-celluloses are the simpler structural forms of annual growths; whereas those of perennial structures are much more complex as such and by reason of secondary interior modification and condensations. The later research work dealt with in the present volume is largely devoted to the latter more complex types, which has inevitably complicated the treatment of the subject.

To resume on the author's sequence of subject matter: in Chaps. viii.-xi. the subject is developed in terms of biochemical science and illuminated by a sustained argument which shapes the matter, treated in all its related aspects, to the satisfactory issue of converging proofs of definite theory.

The subject of these chapters is lignification as an organic process: first, in relation to systematic botany; that is, to the grades of differentiated organic structure from the Thallophytes, with the first appearance of lignification in the Pteridophytes, to the most highly elaborated Phanerogams.

Histological investigation has already recognised an ascending series of types of lignification in close correlation with the evolution of structure; but the author points the way to a positive biochemical treatment of this enormous range of material, hitherto classified certainly without direct reference to lignification. As an illustration of such biochemical method, he briefly discusses the prolonged investigations of Carl Mez, applying his sero-diagnostic processes to the exploration of generic affinities (*Bot. Arch. Königsberg*, 1911 *et seq.*), pointing out, however, that the method is indirect and otherwise subject to error. It is clear that the body of exact knowledge of lignin, the subject of the preceding chapters, supplies a basis of re-investigation of the vegetable kingdom, by indirect method, which he predicts will establish *Ligninbildung* as a critical index of evolutionary development; and outside this objective of science such re-investigation promises a number of collateral developments.

In the next chapter, ix., under the sub-title "Entwicklungs-Mechanik," the organic process implicitly postulated is considered in relation to its factors. Lignification is a primary vital effect, but developed paradoxically *pari passu* with loss of vitality and cessation of growth. But the author refers to a 'post-mortem' activity which supervenes, a respiratory consumption of oxygen at the expense of elaborated cell-wall material; the removal of oxygen followed by complicated condensations, yields as a final product the lignin or lignone complex. It is suggested that the arena and basis of these transformations is the middle lamella of the cell-wall, and evidence of the contributing functions of its pectic components is afforded by the special chemistry of this group of carbohydrate derivatives established by later researches which are fully discussed.

In further development of the conception of the lignin-cellulose complex or ligno-cellulose as a biologic unity or individual, the author boldly grapples with the problem of cellulose constitution. While giving full value to chemical methods and results, attention is rather directed to the physical-biological interpretations of Rontgen spectrographs, to the ultimate configuration of an anisotropic colloid, as a 'cristallite' in evolution to organic form through micellar growth. This text definitely formulates a cellulose lattice and a penetration of the isotropic lignone so intimate as to represent a pseudomorph.

Chap. x. deals with the transformations of the ligno-celluloses and generally of cellulosic structures in fulfilment of ultimate natural functions.

In regard to lignone proper, this is characterised by its well-known extraordinary resistance to reaction, and the only change in living structures which can be traced is in contributing to the formation of phyto-melan. The enormous range of breakdown processes which result in humus, peat, and the various grades of coal, are discussed with general reference to lignin, and also the author's theoretical conceptions in the foregoing text, with reference both to cellulose, pectins and hemi-celluloses, and to the constitution of the lignone complex.

Chap. xi., under the title "Theorien uber Lignin," is a concentrated summary; that is, the author's conclusions on the whole matter.

Chap. xii., and last, is particularly noteworthy. The subject is the technology of lignin and gives the author's scientific rationale of the leading industrial processes for the treatment of ligno-celluloses, such as destructive distillation, pulp manufacture by both acid and alkaline processes, partial resolution of ligno-cellulose structures (cereal straws) to serve as cattle food-stuffs, the production of sugar from wood and wood residues. Avoiding details of the manufacturing processes, the author applies his reasoned conceptions both of the proximate and of the ultimate constitution of ligno-cellulose matter to the elucidation of the reaction mechanism of the several industrial processes. This discussion has distinction as a critical illustration of the sound method of applying science to industry.

In applying, in effect, the most modern and apparently recondite principles of modern science, the text of this chapter should be extraordinarily stimulating to those engaged in industry; not merely in perfecting routine operations but also in devising developments towards realising the progress inevitably suggested by discussion in relation to first principles.

It will be clear from the foregoing that the author has produced a work based on an unusual range of appreciative study of the sciences in their most recent developments contributing to the elucidation of the general theme, which, primarily indicated by its title, extends to the natural history of the vegetable kingdom.

We note in the text a considerable contribution of original investigations, which will probably be the subject of special publications in scientific journals. Lastly, the author is restrained in his criticisms of the researches of his fellow-workers; but a careful study of this work suggests that a notable proportion of the more speculative theories which they endeavour to establish will be excised from the student's memorabilia.

C. F. CROSS.

War Record of the Survey of India.

Record of the Survey of India. Vol. 20: *The War Record, 1914–1920.* (Published under the direction of Colonel-Commandant E. A. Tandy, R.E., Surveyor General of India.) Pp. xxv+155+27 plates +9 maps. (Dehra Dun: Survey of India, 1925.) 3 rupees; 5*s.* 3*d.*

SINCE its foundation in 1767, officers and surveyors of the Survey of India have accompanied every military expedition with which India has been connected. In order to provide a reserve of surveyors for war it has been the policy, as in most other countries, to employ army officers during peace time on the ordinary mapping of the country, so that they may be available at the outbreak of war to provide maps always required during the progress of military operations, though never so much as under the conditions which obtain to-day.

There is no essential difference between peace and war mapping except that in the former case the work is of a more deliberate character, while in war it has, of necessity, to adapt itself to the exigencies of military operations. Until the recent War, tactical topographical maps on a scale of a half or one inch to the mile sufficed, but now trench warfare imposes much larger scales. Artillery maps, also on large scales, require to be of the highest order of accuracy to be of any practical value, while accurate control is required for the location of enemy guns. These new duties have largely enhanced the importance of the surveyor's work in war.

On the outbreak of the War the Survey of India found itself in a position to provide, at once, officers and surveyors proficient in their art ready to take the field in accordance with its long-standing traditions. As the War went on, the call for officers became so insistent for survey and other duties that of the 54 regular officers employed in the Survey of India, 49 went on active service outside India. Of these eight were killed—all officers of the Royal Engineers—and eleven wounded. Of the 44 civilian officers who took part in the War, two were killed and two wounded. In addition, five Indian surveyors and 44 *khalasis* lost their lives in the service of the Empire.

The volume before us is a record of the operations carried out by the officers and surveyors in Mesopotamia, Kurdistan, Macedonia, Arabia, Persia, Palestine, East Africa, and Afghanistan. These explorations and surveys were accomplished in face of many difficulties and in every variety of terrain, from the icy highlands of Central Asia to the waterless deserts of Persia and Arabia. The total area thus explored by members of the department, often in unknown and unmapped regions, is almost comparable to that of Europe, while trustworthy new surveys, based on fixed points, covered an area more than twice that of Great Britain. In addition to a graphic description of the adventures that befell the surveyors in many lands, there is much valuable technical information to be found in the reports as to the methods of survey adopted, suitable to the different situations which presented themselves, and as to the climatic and political difficulties encountered.

The larger portion of the volume is naturally devoted to operations in Mesopotamia and Persia, where by far the greater part of the mapping was carried out. It is a record of intense devotion to duty on the part of officers and surveyors; nor must we forget the Indian survey *khalasi*, whose devotion to duty, whether in peace or war, though occupying but a humble sphere, ranks high among the servants of Government.

A roll of honour is included, and there are a number of photographs illustrating the different types of country concerned, as well as a series of index maps showing the areas actually surveyed. On the whole, this is a most interesting history of survey in war, and its production reflects the greatest credit on all concerned.

Our Bookshelf.

A Text-Book of Inorganic Chemistry. By Prof. Dr. Fritz Ephraim. English edition by P. C. L. Thorne. Pp. xii+805. (London and Edinburgh: Gurney and Jackson, 1926.) 28*s.* net.

PROF. EPHRAIM has written a very modern "Textbook of Inorganic Chemistry," in which the names of Rutherford and Bohr appear in the twelfth line of the text, whilst Laue and the Braggs appear on p. 12 of

Chapter i. This preliminary chapter on atomic structure is followed by three chapters on the properties of the elements. These deal with the periodic system and with allotropy in its various forms, including the colloidal forms of the elements and the special manifestations of allotropy as they are developed in individual elements. Two general chapters are then devoted to the preparation of elements, under the convenient headings of non-metals and metals. The succeeding groups of chapters deal with halogen-compounds, oxides of hydrogen and of the metals, compounds of sulphur, selenium, and tellurium, the nitrogen, phosphorus and arsenic group, and the elements of the fourth group (with boron), whilst a final section describes "The Rare Earths, Alloys and Radioactivity."

The author set out to write an inorganic chemistry which should be as systematic and as readable as a good book on organic chemistry. He has achieved his purpose, in the first place, by assuming that his readers have already reached a stage of development at which they can safely be 'thrown in at the deep end of the bath.' His second device is to omit all systematic treatment of the metals. This makes his task an easy one, since every teacher knows that the chemistry of the non-metals is no more difficult than the chemistry of carbon, and that the memory work and the inevitable dictionary treatment of the subject begin to be troublesome only when he passes from the tiny cluster of non-metals in the top right-hand corner of the periodic table to the vast array of metals which occupy the remainder of the table. It therefore appears likely that the author will be called upon to complete his task by adding to the present volume, which is virtually a text-book of the non-metals, a further volume on the metals.

If these limitations are borne in mind, there is no doubt that a student who has already reached the standard of a pass degree, and wishes to find a suitable book to read in preparation for an honours degree, will find Prof. Ephraim's text-book extremely useful and stimulating. The translation has been issued in a luxurious style, with beautiful print and on thick white paper with ample margins. The cost of the book is therefore not excessive, but it is possible that the student might prefer a less bulky volume, issued at a rather lower price.

Institut International de Chimie Solvay. Deuxième Conseil de chimie tenu à Bruxelles du 16 au 24 Avril 1925. Structure et activité chimiques: Rapports et discussions. Publiés par MM. les Secrétaires du Conseil sous les auspices de la Commission scientifique de l'Institut. Pp. xiv+672. (Paris: Gauthier-Villars et Cie, 1926.) 96 francs.

An account of the second conference of the Institut International de Chimie Solvay, held in Brussels on April 16-24, 1925, has already appeared in these columns (May 23, 1925, p. 817). It is therefore only necessary to note briefly the publication of the official report of the conference. This includes individual reports by Sir William Hardy, Sir William Bragg, Prof. W. L. Bragg, and M. Duclaux, on the structure of primary films, of crystals, and of solid colloids, and reports by Prof. Lowry, Prof. Swarts, M. Tiffeneau, Prof. Perrin, Prof. Job, Dr. Rideal, Dr. E. F. Armstrong, Prof. Moureu, Prof. Armstrong, M. Duclaux and Prof. Euler on various aspects of the mechanism of chemical change. These reports, with the somewhat lively discussions which followed them, make up a volume of nearly 700 pages, which will be read with interest by many of those who did not enjoy the privilege of attending the Conference. The publication of so full a report represents a vast amount of work on the part of the editors, and they are to be congratulated on the successful completion of their task. The only obvious criticism of their work is that in the index to the volume they have introduced two novel examples of multiple personality, by ascribing one report to MM. M. Eric et K. Rideal, and another to the triple authorship of MM. Thomas, Martin et Lowry.

One constructive suggestion may be made. Since the reports were first written in English or French, according to the nationality of the author, it would be a real advantage to be able to read them in the original language rather than in a necessarily imperfect translation. The printing of the final report in alternating French and English sections would surely not be a serious handicap to Belgian and French readers, whilst to English and American readers it would give a guarantee of authenticity and precision of phrasing that would be of even more value than the greater facility of reading in one's mother-tongue instead of in a foreign language.

L'Art et la religion des hommes fossiles. Par G.-H. Luquet. Pp. 231. (Paris: Masson et Cie, 1926.) 4*s.* 4*d.*

M. Luquet is a stern critic of facile theorising, and he will have none of the wholesale application of analogies from the practices of primitive people to the interpretation of the facts of palæolithic culture unless supported by internal evidence. Witness his treatment of the theory that the figures of animals carved, engraved, and painted were designed with the object of the magical increase and control of the game supply. This, he maintains, can only be asserted when the animal is represented as smitten by the weapon of the hunter. He leans definitely, therefore, to the view that while the magic employment of art may be predicated of the Magdalenian period, it scarcely exists, if at all, in the Aurignacian period. When once the possibility of representation had been grasped, it was practised for its own sake, it was purely æsthetic, and its magical uses were secondary. In the same way he refuses to accept the grosser form of female representations as evidence of a mother goddess cult, but regards them as erotic. The group of women encircling a male figure at Cogul, usually regarded as a ceremonial dance, is discussed at some length. Every aspect of palæolithic art, the cult of the dead and religion and magic, he touches upon in similar vein. M. Luquet's treatise is, with its cold logical outlook, certainly stimulating, though not always convincing. With no desire to dogmatise, it may very fairly be said that the weight of evidence as we know it at present is in favour of the magical rather than the purely æsthetic character of primitive and prehistoric art. As a corrective, however, to over-hasty enthusiasm, M. Luquet's book should be pondered by every student of prehistoric culture.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Origin of an Albino Mutation in *Limnaea peregra*.

THE normal colour of the head, mantle, and footsole of the pond-snail *Limnaea peregra* is a yellowish grey of variable intensity which is clearly visible through the horn colour of the shell. The eyes are black. During the course of our experiments with the sinistral form of this snail (*Jour. of Genetics*, 15, 113) a new mutant has appeared in which the head, mantle, and footsole are yellow and the body has no melanin anywhere. The eyes are visible as brownish specks, contrasting with the deep black of the normal specimens. The appearance is presumably a diffraction effect of the lens, for microscopically there is in young specimens no retinal pigment, though in snails that have grown up and bred a little brown-black pigment can be seen in the retina. We call this mutant 'albino-body.'

Albino-body first appeared in a sixth generation brood from a single isolated (*i.e.* self-fertilising) normally pigmented sinistral snail (brood 1629). This brood at the time of counting consisted of 65 normally pigmented, 22 albino-body, and 74 dead, which of course could not be classified. Clearly the parent snail was heterozygous for the albino factor. This snail was one of a normally pigmented brood derived from isolated singles for three generations back. Eight pairs and seven other isolated singles were carried on from among its sisters and gave broods totalling 4859 young. In none of these 15 broods were any albinos found. Three of these broods were carried on to the next generation and 721 young obtained: again no albinos were found.

In terms of chromosomes, if isolated single (self-fertilised) snails are used, any new recessive mutation must make its presence apparent in the brood given by the first animal to contain the mutant chromosome. It seems clear, then, that the mutation occurred in one chromosome of the germ cells responsible for the parent snail of brood 1629.

Thirty-three snails from this brood were used for further breeding and gave the results set out in Table I. The albinos, as would be expected, bred pure for albinism. For the 27 pigmented snails tested as parents the expectation would be 9AA to 18Aa, the results on the most favourable basis give 10AA to 17Aa, on the least favourable, 12 : 15 (according to the actual composition of the pairs 7596 and 7599). The total classified young from the 12 mixed broods given by Aa parents is:

	Pigmented.	Albino.
	1825	607
Expectation	*1824*	*608*

There seems to be no differential infantile mortality, for whether the death-rate is 79 per cent. (7667) or 12 per cent. (7674) the agreement with expectation among the living remainder is equally close. Pigmented and albino snails come from the same capsule of eggs.

Accurate counts cannot be made with young that have only just hatched, but within a month or so the two types stand out remarkably clearly without any intermediates, and when spread out in the counting-dish give an excellent occular demonstration of the simple 3 : 1 ratio. The material might be useful to those engaged in demonstrating elementary Mendelism to classes. The technique of breeding the snails and counting the results is very simple, and, with only a few bottles, involves a negligible expenditure of time and money. Snails planted out in the spring will, under proper conditions, give broods that may be counted from August to November, and require no attention between planting and counting. There are large quantities of the albino strain at present available for distribution, if required. In the normal course of our experiments these will be thrown away in February.

TABLE I.

Snail used as Parent.	Paired or Single.	Resultant Brood.			
		Pigmented.	Albino.	Dead.	Total.
7590 Albino . .	Pair	..	443	79	522
7591 " . .	"	..	180	190	370
7592 " . .	Single	Failed to breed.			
7593 " . .	"	..	173	142	315
7596 Pigmented . .	Pair	519	..	153	672
7599 " . .	"	370	..	16	386
7594 " . .	"	115	35	11	161
7595 " . .	"	230	82	11	323
7597 " . .	"	212	81	62	355
7598 " . .	Single	Gave mixed brood, but accurate count not made.			
7601 " . .	"	190	..	2	192
7602 " . .	"	244	..	114	358
7604 " . .	"	307	..	14	321
7665 " . .	"	311	..	83	394
7668 " . .	"	293	..	38	331
7669 " . .	"	248	..	335	583
7670 " . .	"	215	..	445	660
7672 " . .	"	210	..	684	894
7600 " . .	"	196	59	50	305
7603 " . .	"	184	64	104	352
7605 " . .	"	154	44	477	675
7666 " . .	"	131	40	18	189
7667 " . .	"	109	36	537	682
7671 " . .	"	69	21	.	90
7673 " . .	"	142	49	102	293
7674 " . .	"	218	74	40	332

A. E. BOYCOTT.
C. DIVER.

University College Hospital
Medical School,
Gower Street, W.C.,
November 17.

Active Nitrogen.

IN the Research Items in NATURE for September 18 and in correspondence in the issues of October 23 and November 20, attention has been directed to experimental work by Willey and Rideal (*Jour. Chem. Soc.*, July 1926) which led them to suggest that active nitrogen consists of metastable molecules having an energy of about 42,500 cal. per gm.-mol. (= about 2 volts).

Such a view is, however, difficult, if not impossible, to reconcile with spectroscopic data. Ludlam and Easson have pointed out one type of difficulty in the case of the production of such a line as that at λ2061 in the iodine spectrum, which requires an energy of some 150,000 cal. for its excitation. In reply to this, Mr. Willey has suggested that a quasi-stable molecule may first be formed (such as N_2I_2)—presumably by impact of an active nitrogen molecule and an iodine molecule—the energy of which may be released by a second active nitrogen molecule and the total energy should be adequate to excite the iodine line. This, however, is scarcely possible, for the maximum energy which the break-up of the above semi-stable molecule could yield is that of the active nitrogen molecule which produced its formation. When this is added to the energy of the impinging active molecule it only gives as available energy of excitation twice that of a *single* active nitrogen molecule (which would, according to Willey and Rideal, be 85,000 cal.). In practice, the energy available for exciting the iodine line will be still less by the amount required to dissociate first the iodine molecule.

As an alternative Mr. Willey suggests that the excited NO molecules which yield the β and γ groups of the afterglow spectrum may be responsible for excitation of the line. In this particular case this is just possible, although it is near the limit which these molecules can possess. The (0, 0) band of the β group requires almost 6 volts for its production, and even taking the extreme case that an excited NO molecule is loaded with vibrational energy up to the point of dissociation, its available energy would be only 7·9 volts or 182,000 cal. (*vide* Birge and Sponer, *Phys. Rev.*, vol. 28, p. 283, 1926). In general, therefore, activated NO molecules cannot account for all the spectra which active nitrogen is known to be capable of exciting.

In accordance with the views expressed by Birge, Sponer, and others, it seems highly probable that active nitrogen is really atomic nitrogen, which is equivalent to an energy of 11·4 volts (= 263,000 cal.), and this appears as radiation in the ordinary process of recombination. Contrary to the implication of Mr. Willey in his letter to NATURE (November 20), this evaluation of the energy is not based primarily on the ability of active nitrogen to excite *other* spectra but on the nature of its *own* spectrum (*i.e.* the α group). The peculiar limitation of the first positive band spectrum, which it comprises, receives a natural explanation on the assumption that about 11 quanta of vibrational energy (= 2·1 volts) in addition to the 9·3 volts of electronic energy, are sufficient to effect dissociation of the N_2 molecule. Consequences which follow from this have been verified by quite different lines of experiment (*vide* Birge and Sponer, *loc. cit.*).

In explanation of their theory that active nitrogen consists of metastable molecules excited to about 2 volts, Rideal and Willey write that "to effect this excitation it appears that the molecule has to be excited to a high level (11·5 volts) but the electronic energy rapidly disappears after departure of the gas from the discharge zone. . . ." This can scarcely be the case, for 2 volts energy are inadequate to account for the afterglow spectrum (α group), more especially as we now *know* that the final electronic state of the molecule after this emission is 8·0 volts above the normal.

R. C. JOHNSON.

Department of Physics,
Queen's University of Belfast.

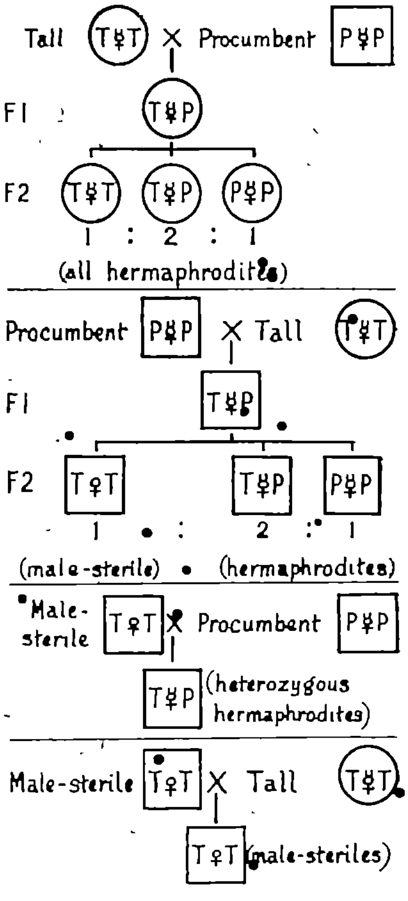
A Suggested Interpretation of Certain Cases of Anisogeny.

MANY cases are known in which the results of reciprocal crosses between green and variegated plants fail to agree. In all these cases the progeny reproduce the appearance of the female parent alone. Cases are also known in which a cross made one way between two true breeding green races results in variegation, whereas in the reciprocal cross the appearance of variegation is either deferred to a later generation or is absent. We know that the female contributes all, or the greater part, of the cytoplasm, and it has therefore been supposed that the cytoplasm, or its inclusions, is partly or wholly responsible for this difference in inheritance. Can this difference in the contribution of the male and female account for the dissimilar results of reciprocal crosses in other characters than variegation?

In crosses between the Tall and Procumbent races of ***Linum usitatissimum*** a peculiar abnormality (male-sterility) occurs in the F2, and is inherited as a simple Mendelian recessive (Bateson and Gairdner, *Jour. of Gen.*, 11, 3, 1921). This character only appears when Procumbent is the female parent in the original cross. No male-steriles occur in F1 or F2 of the reciprocal cross of Tall by Procumbent. Male sterility, then, only appears when there is cytoplasmic continuity from Procumbent.

We suggest that this difference in inheritance is due to a dissimilarity in the cytoplasms of Procumbent and Tall. Individuals of the F1, and later generations resulting from the cross of Procumbent by Tall, would have cytoplasm contributed by Procumbent, whereas the progeny of the reciprocal cross would have Tall cytoplasm. Though a particular Procumbent gene, or group of genes, reacts normally in both cytoplasms, the corresponding factor, or factors, in the Tall, when homozygous in Procumbent cytoplasm, gives rise to male-steriles.

This may be shown diagrammatically thus:



○ — cytoplasmic constituent of the Tall.
□ — " " Procumbent.
T — a gene, or group of genes, of the Tall.
P — a corresponding gene, or group of genes, of the Procumbent.

It will be noted that male-steriles crossed with the pure Tall race give only male-steriles. Hence the Tall race was considered by Dr. Bateson to be heterozygous for the element determining hermaphroditism, this element passing solely to the ovules, the pollen being devoid of it. Such phenomena of unlikeness in the genetical constitution of pollen and ovules Dr. Bateson called anisogeny, in opposition to isogeny, the normal state in which they are equivalent. The example of anisogeny in flax he attributed to somatic segregation occurring at the formation of male and female organs In the course of last year, however, he considered the possibility of applying a scheme similar to that above described and illustrated, but, owing to two or three inconsistencies in the experimental material, he was not wholly satisfied with it. The inconsistencies remain; but critical evidence is now available in flax, which, though incompatible with the original interpretation, is in perfect harmony with that now proposed. Additional evidence is also provided by a similar case of anisogeny in Geranium, observed here by W. C. F. Newton and Miss A. Sverdrup (unpublished).

It is perhaps needless to say that the present scheme does not apply to Matthiola, or at least does not do so in any simple form.

R. J. CHITTENDEN.
CAROLINE PELLEW.

The John Innes Horticultural Institution,
Merton, S.W 19,
October 29.

Chinese Alchemy.

IT is generally agreed that chemistry had its origin about the first century A.D. at Alexandria, where the Egyptian metallurgical and technical arts combined with speculative philosophy and theosophy to form a belief in the possibility of the transmutation of metals into gold. On the conquest of Egypt by the Arabs in A.D. 640 this knowledge passed to Arabia, largely through the intermediary of Syriac translations of the Greek treatises. Arabic chemistry is not earlier than the seventh-eighth century A D. and appears to be greatly dependent upon that borrowed from Alexandria

Berthelot ("Archéologie et histoire des sciences," Paris, 1906) considers that Chinese alchemy was derived from the Arabs He relies principally on a correspondence with Terrien de la Couperie, but the opinion of the latter is not quoted in detail. Since the late origin of alchemy in China which this implies is very definitely in contradiction to the Chinese accounts, Berthelot assumes that the latter are largely interpolated, and that the parts dealing with alchemy are additions made after about A.D. 700 He supports this theory by the statement that information about China is really comprised in eighteenth-century native editions of works not usually earlier than A D. 1000, that is, after the best Arabic period

There seems to be no evidence that Chinese alchemy is of Indian origin. The earliest treatises on alchemy in India are definitely later than the Arabic period and are probably based on Arabic sources, although if Chinese chemistry is earlier than this the possibility of Indian alchemy coming from China may be considered Writers on Chinese science, except Giles, all claim its originality, but they do not seem to be acquainted with the activity of the school at Alexandria, and generally assume that chemistry began with the Arabs in the eighth century A.D., which was the usual idea until Berthelot's publication of the Greek treatises of the Alexandrian school, portions of which had been published by Hoefer. The earliest of these are about seven hundred years before any chemistry was known to the Arabs. Giles ("Encycl. Britt." art China) states that Chinese chemistry is of Greek origin, but the date he gives for it, about 150 B.C. (in agreement with native accounts), is much too early for that source to be possible, unless there was a school of chemistry flourishing in Europe of which we have now no trace whatever. This is highly improbable.

The occupation of Taoist circles with the preparation of an elixir of life and the philosopher's stone is mentioned by Se-Ma-Tsien as prevalent in the reign of Wu Ti (140–86 B.C.). The accuracy of Se-Ma-Tsien seems to be unquestioned, and the account is nearly contemporary. Berthelot refers to this, but is forced to conclude that these Chinese accounts have been interpolated since A D. 700. It is stated in Chinese sources which are available in translations that Hoei-nan-tsze was an alchemist, and a chapter of his works called "On Bodily Things" deals with alchemy. A translation of part of this has been published by de Harlez and seems to confirm this, but one cannot be sure unless the whole account is considered. Se-Ma-Tsien also reports that a magician Li Siao Kiun advised the Emperor Wu Ti to sacrifice to the alchemist's furnace so that he could call on supernatural beings who would help him to change cinnabar into gold. If the dates are authentic, this is before the earliest alchemy otherwise known.

The most celebrated Chinese alchemist is stated to have been Ko Hung or Pao Pu Tse, who lived in the fourth century A D. This would be just about the period when the Alexandrian school was very active, and the possibility of his being influenced by it is rather important, but it is long before the Arabic period. He is said to have written a book called "Niu pien," part of which deals with alchemy. Berthelot refers to this text but doubts its authenticity Extracts from Ko Hung are published by Edkins (*Trans. China Branch Roy. Asiatic Soc.*, Hong Kong, 1855, part 5, pp. 83-99), whose memoir is practically the only source of information on the subject, and they indicate an advanced theory and practice of alchemy.

My object in directing attention to this subject is to make it clear that any conclusions which may be drawn as to the dates of Chinese texts which are based on the belief that accounts in them of alchemy must have come from Greek or Arabic sources are highly doubtful, since the actual position is uncertain. A consideration of all the information on Chinese alchemy which is available to me in European languages has left me with the conviction that the matter is still quite open and that any other view, such as the one adopted by Berthelot, is doubtful. It is to be hoped that the attention of competent Chinese scholars may be attracted to what would be a most interesting and valuable period in the history of chemistry.

J. R. PARTINGTON.

Kingsbury Close, Kingsbury,
London, N.W.9.

Formation of Calcareous Tubes round the Siphons of Teredo.

AT the beginning of June 1926 a quantity of wood heavily infected with Teredo (probably all *Teredo norvegica*), taken from the experimental rafts moored near the Plymouth breakwater, was placed in one of the tanks in the Plymouth laboratory. It was left undisturbed for almost four months, and when examined at the end of September was found covered with fæcal deposits consisting of wood fragments cut away by the shell valves of Teredo and passed out by way of the exhalent siphons. These deposits were, on the average, rather less than half an inch thick, and when they were washed away there were revealed, projecting from the wood, great numbers of fine calcareous tubes, which on closer examination proved to occur always in pairs and to project from the openings of the burrows formed by the shipworms. Plainly the tubes had been formed around the siphons of the Teredo. They were of varying length, depending presumably on the thickness of the deposits, the longest being some two-fifths of an inch. The general appearance of the wood is shown in Fig 1.

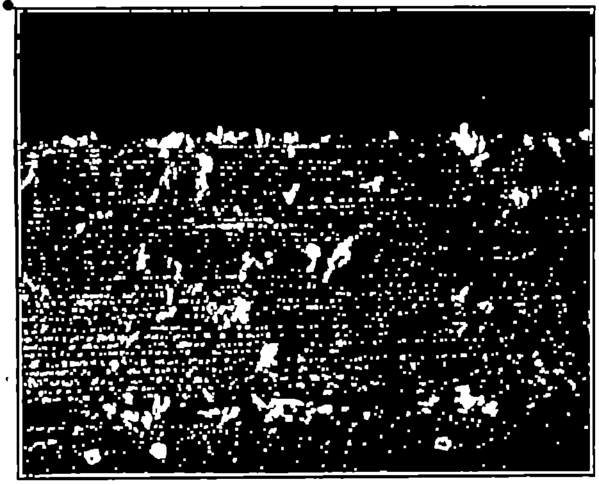


Photo.] [*A. J. Smith.*

FIG. 1.—Portion of wood badly infected with *Teredo norvagica* The white objects are the protruding calcareous siphonal tubes which appeared after the fæcal deposits had been washed off. In several cases the paired tubes can plainly be distinguished.

Normally the external openings of the tubes of Teredo are very difficult to distinguish, consisting of a pair of minute openings ringed with calcareous matter out of which project the siphons and within which these are immediately withdrawn on stimulation. The presence of fæcal deposits, which had accumulated to an abnormal degree owing to the lack of water currents to remove them, would tend to obstruct the passage of the siphons and so endanger the life of the animals within. The response of the animals to this abnormal and dangerous state of affairs was to lay down calcareous tubes around the siphons, which by this means were able to maintain free contact with the water.

Dr W. T. Calman has directed my attention to the fact that the giant shipworm, *Kuphus arenarius*, which lives vertically embedded in the mud of mangrove swamps in the Pacific, normally has the siphons encased in this manner, a fact which was known to Rumphius so far back as 1741, and was figured by him (as *Solen arenarius*) in his "D'Amboinsche Rariteitkamer" This animal lives normally under conditions in which the Teredo in the Plymouth tank lived for some four months, namely, in constant danger of being suffocated by accumulating deposits—in one case of mud, in the other of fæcal matter.

This accidental production of calcareous siphonal tubes in Teredo is therefore of some considerable interest, since it provides a very striking case of an immediate and highly successful response by an animal to changed environmental conditions; a response, moreover, which has taken the form of a permanent adaptation in related animals living under conditions very similar to those accidentally produced.

C. M. YONGE.

Marine Biological Laboratory,
Citadel Hill, Plymouth,
November 15.

Fluctuations in the Abundance of a Species considered Mathematically.

WITH regard to Prof. Volterra's interesting article, "Fluctuations in the Abundance of a Species considered Mathematically," in NATURE of October 16, page 558, I may be permitted to point to certain prior publications on the subject, of which Prof. Volterra seems to be unaware. The general theory as well as a number of special cases have been set forth in "Elements of Physical Biology" (published by Williams and Wilkins, Baltimore, 1925), in which work a considerable number of references to the journal literature are given. Among other things Prof. Volterra's diagram "Fig. 2" will be found on page 90 of the book cited; the expression for the period of isochronous small oscillations in the case of two species is also found on the same page. Prof. Volterra refers to certain applications of his analysis to problems of sea fisheries, to a passage in Darwin's "Origin of Species," to extinction of species, to pathogenic germs, and to parasitology. An application to sea fisheries is found in the book cited on page 95, to a passage in Herbert Spencer on page 61; to the extinction of species on pages 94, 95; to pathogenic germs on pages 77, 79, 147 *et seq.*; to parasitology on page 83.

The effect of introducing a third species into a system of two species is discussed on page 94; the effect on equilibrium of changing various factors is treated in Chap. xxi., "Displacement of Equilibrium," and, in particular, the effect on equilibrium between food and feeding species is analysed on page 289. The distinction between oscillatory and aperiodic systems, and its relation to certain quadratic forms, is referred to on pages 146, 148, and 159.

It would be gratifying if Prof. Volterra's publication should direct attention to a field and method of inquiry which apparently has hitherto passed almost unnoticed.

ALFRED J. LOTKA.

Metropolitan Life Insurance Company,
New York City, October 29.

In the above letter from Dr. Lotka, which is in accordance with our preceding correspondence, following upon the publication of my article in NATURE, he justly observes that he had obtained the differential equations in the case of two species, one of which feeds upon the other, that he had given, as well as myself, the same diagram of the integral, and also the period in the case of small fluctuations. In this I recognize his priority, and am sorry not to have known his work, and therefore not to have been able to mention it.

I did not even know other publications of the same kind by other authors, for example, the work of Sir Ronald Ross on malaria, which precedes the writings of Dr. Lotka, who has, however, found so many new and important results.

The other observations mentioned in the above letter refer to points which I have not treated; but as to the sea-fisheries, while I refer to the laws (which I believe to have been the first to formulate) and principally to the third law, which gives an easy way of calculating the maximum output of fisheries; he, on his part, considers the case of the addition of a third species, which seems to me a different problem.

I also think that the quotation of Darwin's acute intuition referring to my third law, and the quotation from Spencer, which touches only the principle of the existence of fluctuations, are essentially different.

I think that the study of the general case of the convivence of *n* different species, subject to the hypothesis which permits me to distinguish the case of conservative association from that of dissipative association, and to obtain integrals and laws of fluctuation which form the essential and the greatest part of my memory, is absolutely new. To conclude, I recognize the existence of some common points in Dr. Lotka's work and my own, in which he has priority, but my work and his diverge in all the rest.

Working independently the one from the other, we have found some common results, and this confirms the exactitude and the interest in the position of the problem I agree with him in his conclusions that these studies and these methods of research deserve to receive greater attention from scholars, and should give rise to important applications.

VITO VOLTERRA.

Via in Lucina, 17,
Rome, November 27.

The Polishing of Surfaces.

DR. HAMPTON of West Bromwich has directed my attention to Mr. J. M Macaulay's letter on "The Polishing of Surfaces" in NATURE of September 4, p. 339.

In conversation with Sir Herbert Jackson, Mr. Twyman, and others, I have once or twice had occasion to point out that the energy available in practice for liquefying the surface layer of glass is many hundreds of times what is theoretically necessary. It is known that in polishing glass, the amount of glass removed corresponds to a solid layer of the order of ten wave-lengths in thickness. The total quantity of heat necessary to liquefy or even vaporise a layer of this thickness is not great in comparison with the energy expended in the actual process of polishing. The figure given by Sir George Beilby of four pounds per square inch as a pressure sufficient to start flow has no significance. In the process of polishing glass on a commercial scale, pressures very much less are the rule. In the polishing of plate glass, for example, they are of the order of half a pound per square inch, in the spectacle industry they are commonly of the same order; in the optical industry the specific pressures used become greater and greater as the surface becomes smaller

There is every reason to believe that glass will polish with the most insignificant pressures that can be attained in practice; but of course the lower the pressure the longer the time required. The coefficient of friction which Mr. Macaulay takes as 0·3 is a long way out. In polishing with felt and similar materials the coefficient ranges from about 0·85 to 1·1, and is usually taken by designers as from 0·95 to 1·0. In polishing with pitch the apparent coefficient of friction fluctuates very widely, because the film of moisture between the pitch and the glass renders the interfacial pressure itself either very great or very small according as the quantity of moisture becomes less or greater. However, whatever assumptions may be made about the pressures and coefficients of friction, it may be taken that in the polishing of large surfaces of glass about [illegible] kilowatt hour is expended over a square foot of surface polished. In the optical industry, where surfaces are smaller and preliminary grinding is better, an expenditure of energy of about half this amount suffices. From this it may be calculated, I think, that the efficiency of the glass polishing operation is (on the assumption that the energy is required for liquefying a thin surface layer) not more than about one-half of one per cent

I am not a great believer in the surface flow theory. In various papers to the Optical Society of England and elsewhere I have given reasons for believing that whatever part surface tension effects may play, the process of polishing is at bottom primarily one of abrasion.

F. W. PRESTON.

222 E. Clay St.,
Butler, Pa., October 26.

THE practical information which Mr. Preston gives is of considerable interest and value. His observations appear, on the whole, to support the view expressed in my previous letter, that glass surfaces are actually fused in the process of polishing.

One wonders whether the conception may not approximate in some degree to Mr. Preston's belief that "the process of polishing is at bottom primarily one of abrasion." One can imagine the surface molecules in the liquid state being, so to speak, picked off by the rouge particles, thus giving, so far as the resulting debris would indicate, an abrasion effect.

JAMES M MACAULAY.

Natural Philosophy Department,
The Royal Technical College,
Glasgow, C.1,
November 24.

Origin of Yolk in the Eggs of *Luciola gorhami*.

THE eggs of the coleopteran fire-fly, *Luciola gorhami*, found in the plains of the Punjab, have proved to be objects of rare value for the study of the problem of the origin of yolk There are two kinds of yolk in these eggs. albuminous and fatty. The former arises directly from nucleolar extrusions of a remarkable type At a very early stage in the growth period the nucleolus shows signs of intense activity and buds off numerous round bodies of different sizes, which are thrown out in the cytoplasm. The nucleolus continues to throw out these extrusions until the very last stage in oogenesis At the beginning of this process the extrusions migrate towards the periphery of the egg-cytoplasm, where they grow in size, perhaps at the expense of food materials derived from the follicle cells

The whole process is reminiscent of what has been described in the cockroach and certain Hymenoptera, by Hogben (*Proc. Roy Soc.*, 1920, A, and 1920, B) and in Saccocirrus by Gatenby (*Quart. Jour. Micr. Sci.*, 1922). Nucleolar extrusions preceding the appearance of albuminous yolk have, of course, been described in some other eggs, e.g Lithobius (King, *Scient. Proc. Roy. Dub. Soc.*, 1924, and Nath, *Proc. Camb Phil. Soc. Biol. Sci.*, 1924) and Buthus and Euscorpius (Nath, *Proc. Roy. Soc.*, 1925), etc., but in Luciola it is noteworthy that the process of nucleolar budding lasts practically throughout oogenesis, and the process of the growth of nucleolar extrusions into the albuminous yolk spheres can be studied with diagrammatic clearness.

The origin of the fatty yolk from the Golgi elements is no less clear. The latter exist in the form of rings and crescents. The rings might also be appropriately described as vacuoles (cf. 'vacuome' theory of Parat), with a sharp chromophilic rim and a central chromophobic substance (idiosome). When the solid osmicated fat spheres are decolorised in turpentine they also show a chromophilic rim and a central chromophobic substance, exactly like the Golgi rings. On further decolorisation they appear like clear vacuoles.

We emphasise this morphological similarity between the Golgi rings and the fatty yolk spheres. It seems clear that the fat spheres arise directly from the Golgi rings, in the interior of which free fat, not miscible with the general cytoplasm, is deposited. In the undifferentiated germ cells the Golgi apparatus exists in the form of about four rings lying on the edge of the nuclear membrane, and we further emphasise the remarkable and unique fact that the Golgi rings of some germ cells are saturated with free fat long before the egg is differentiated from other cells.

A full account will be published later.

VISHWA NATH
(Bhupendra Research Laboratory,
Patiala).
DEV RAJ MEHTA
(Government College, Lahore).
October 14.

Solar Radiation and Athermancy.

THE efficacy of a material in excluding solar heat is a complex function. For practical purposes, however, athermanous materials may be graded in terms of an empirical transmission factor,

$$F = (1 - R)/\{1 + (1 + E_2)[1/(1 + E_1) + 1/K]\},$$

where K is the conductivity (B.Th.U. per sq. ft. per degree Fahr. per hour), E_1 the emissivity of the inner surface, E_2 the emissivity of the exposed surface and R its reflecting power for solar radiation. Both surfaces are presumed to be in contact with air. Values for a few materials are tabulated below.

Material	Inner Surface	Exposed Surface	E_1	E_2	R	K	F
Metal sheet .	Silvered	Silvered	0·02	0·02	0·90	large	0·05
1 in. wood .	White or black paint	White paint	0·95	0·95	0·70	1·0	0·08
3 in. wood .	„ „ „	Black paint	0·95	0·95	0·05	0·3	0·11
1 in. wood .	„ „ „	„ „	0·95	0·95	0·05	1·0	0·24
Metal sheet .	Silvered	Blackened	0·02	0·95	0·05	large	0·33
Metal sheet .	Blackened	„	0·95	0·95	0·05	large	0·48

It would be of interest to know whether there is any anomaly in this grading.

A. F. DUFTON.

Building Research Station,
Garston, Herts, November 23.

An Amusing Conception of Scientific Discovery.

THE want of touch between politicians and science, at all events a score of years ago, is amusingly illustrated in the following extract from the official report of a speech made by the Marquis of Lincolnshire in the House of Lords on Dec. 6 last.

He was speaking on the Small Holdings and Allotments Bill, and was describing discussions which, when Minister for Agriculture in Sir Henry Campbell-Bannerman's Government, he had with the Prime Minister about the introduction of the Bill which emerged as the Small Holdings and Allotments Act of 1908.

The extract is as follows :—

"Sir Henry Campbell-Bannerman pricked up his ears and said: 'What a curious thing it is how the same wonderful sentiments and ideas sometimes simultaneously strike the noblest minds. I will give you an instance. When I was at Cambridge in the 'fifties there was a great big hulking undergraduate at St. John's College. He must have been very clever because, going one starry night for a ramble, he looked up at the firmament on high and discovered a planet. It was a wonderful thing to do, but it was absolutely true that that man discovered a planet, and, curiously enough, that very same night an old Frenchman, squinting through an opera glass or a telescope or something of that sort, discovered it too.' And that, Sir Henry Campbell-Bannerman said, was a very wonderful development and almost a precursor of the *entente cordiale*."

It required an effort, at all events on the part of one reader, to recognise this highly original account of the simultaneous discovery of Neptune by Adams and Le Verrier in 1846.

X. Y.

December 13.

An Unclaimed X-ray Spectrometer.

IN the hope that we may be able to restore a piece of lost property to its owner, we would greatly appreciate the publication of the following facts.

Recently the New York Central Railroad had an auction sale of unclaimed baggage. One of the pieces of baggage contained what appears to be a simple X-ray spectrometer with a fluorescent scale for visual observation. The purchaser brought the apparatus to us for identification, and he is willing to restore it to its owner if we can locate him.

The instrument was sent as baggage on the New York Central Railroad from Albany, N.Y., to Chicago, where it arrived at 10.00 A.M. on October 21, 1924, presumably on the Twentieth Century Limited. The date makes it appear possible that the apparatus may have belonged to someone who attended the meeting of the British Association for the Advancement of Science in Toronto. The instrument was manufactured by Schall and Son, of London.

Inquiries should be directed to the undersigned, who will take the necessary steps to have the instrument returned to its owner.

PAUL E. KLOPSTEG.

Central Scientific Co., Chicago,
Illinois (U.S.A.).

The Oogenesis of Lumbricus.

I FEEL compelled, much against my own and Prof. Gatenby's feelings, to reply to his letter in NATURE of December 11. In the first place, I do not quote in my bibliography papers which I have not carefully read. In the second place, I have read the papers on yolk formation which Prof. Gatenby recommends. Hence my desire for an attempt at co-ordination of the divergent observations on this phenomenon in oogenesis. Lastly, may I record my agreement with him on the subject of Harat's work? I think his evidence is very strong, yet, at the same time, I would prefer to "add facts" and "avoid discussion" of work which is even yet in its infancy.

L. A. HARVEY.

University of Edinburgh,
December 15.

'Sun Circles' in Ritual Dances.

IN connexion with Miss Violet Alford's lecture on ritual dances, reported in NATURE of December 4, it would be interesting to know whether anthropologists familiar with ritual dances among tribes of the southern hemisphere, for example, the Australians, have noted in these the practice of dancing 'sun circles' in the reverse direction, which we should call 'widdershins.' As the apparent path of the sun in the southern hemisphere runs in the contrary direction to its path in our hemisphere, that is, from east through north to west, sun circles should surely be danced in this direction also.

W. E. F. MACMILLAN.

42 Onslow Square, London, S.W.,
December 6.

Regions of Compression.[1]

By Dr. J. W. EVANS, F.R.S.

I.

IT is usual to contrast the horizontal forces acting on the earth's crust with those that are vertical and to regard the latter as more fundamental and important. This attitude is apt to be misleading, although it rests on a foundation of fact, if it be true, as is generally believed, that most horizontal forces are ultimately to be attributed to the contraction on cooling of the earth's interior, which lets down the crust so that it has to accommodate itself to an area less extensive than that which it previously occupied.

The discovery, however, of the release of energy in the course of the atomic degradation of uranium and thorium and their products caused a reconsideration of the question. It is true that the amount of radioactive materials diminishes as the basicity of the rock increases, and there is every reason to believe that the deeper rocks are more basic than those nearer the surface, but it is contended that, even if this be allowed for, the energy given out by them in their disintegration, converted into heat, would cause a rise instead of a fall in the earth's temperature. Prof. John Joly believes that this has in the past led to catastrophic developments characterised by great outpourings of lava. But, although the whole of the energy given out by radioactive elements, when isolated, is converted into heat, it is probable that a considerable proportion of the energy liberated by such elements, when they occur as rock-constituents, is used up in effecting physical, chemical, or atomic changes in the surrounding minerals.

That much of the radioactive energy set free in the disintegration of radium and thorium is absorbed in other ways than in raising the temperature of the rocks is clearly shown by the formation in certain circumstances of 'pleochroic haloes' round radioactive minerals. This occurs especially in the case of zircon embedded in biotite mica. Such a halo is a sphere with a radius of about 30 microns, and has a minute zircon at the centre. It is of a darker and a deeper brown and far more pleochroic than the rest of the mica. The difference is usually assumed to be the result of ionisation by the radiations from uranium and thorium contained in the zircon. The possibility of atomic changes under the influence of the α rays must, however, not be ignored.

The formation of the haloes must involve a considerable absorption of energy, the magnitude of which will be realised when it is remembered that the mass of the halo may be some 15,000 times that of the zircon at its centre, and more than 300,000 times that of the uranium and thorium to which the halo owes its existence. Nor is it probable that this absorption is confined to the pleochroic haloes.

It is, therefore, doubtful whether there is any considerable excess of radioactive energy available for raising the temperature of the earth.

The zone in which appreciable cooling takes place must extend over only a small fraction of the earth's radius, and the question arises whether the contraction from cooling in this zone is sufficient to account for the folding that we know to have taken place.

Dr. H. Jeffreys estimates that the actual crumpling and overthrusting observed in the principal mountain-chains of the earth has resulted in a decrease in the area of its surface of 2,000,000 square kilometres. At the same time, he calculates that the cooling that is taking place in the earth's interior will, on the basis of the observed coefficient of expansion of the rocks of the earth's crust, result in a decrease in the area of the surface amounting to rather more than 4,000,000 square kilometres.

Now, the folding of the mountain ranges included in this calculation by no means represents the whole of the folding to which the earth's crust has been subjected. Many folded areas are no longer mountainous. They are the sites of ancient ranges which have since been planed down.

It is, therefore, probable that the contraction to which the folds and overthrusts bear witness exceeds that which Dr. Jeffreys believes to have resulted from the cooling of the earth's interior. There is, however, little doubt that far greater contraction has taken place.

The sedimentary and the acid igneous rocks of the continents, which constitute the sial, are apparently underlain, at a depth variously estimated at from 100 to 15 km. by the sima: that is to say, basic and ultrabasic crystalline rocks, or magmas of similar composition, except that they contain water and other volatile constituents.

Dr. Jeffreys bases his calculations of the amount of contraction on the coefficient of expansion of specimens of crystallised rocks which have, of course, lost most of the volatile constituents that they possessed when in the state of uncrystallised magma. Yet, judging from the amounts given off in the course of volcanic eruptions, such as those of Hawaii, volatile substances must form an important proportion of even a basic magma, which will accordingly have a much higher coefficient of expansion than the crystallised rock.

Dr. Jeffreys calculates, however, that the sima is crystalline down to a depth of more than 600 kilometres. This is because he takes the crystallisation point of a basaltic magma under atmospheric pressure at 1200° C. and that of a peridotite at 1400° C. These, however, are the temperatures at which the crystallised rocks that have lost their volatile constituents can be remelted. We know from the observations of T. A. Jagger that the basaltic magma at Kilauea, which retains some, though by no means all, of its volatile constituents, remains fluid at 750° C. It is true that he assumes that the magma was supercooled, but there is no evidence of this. There can be no doubt that the crystallisation point of a basalt- or even a peridotite-magma retaining its volatile constituents would be considerably less than that at which the crystallised rock can be remelted.

It is also assumed by Dr. Jeffreys that the crystallisation point is raised by 3° C. for every additional kilometre of depth, on account of the increase of pressure. This is a fair estimate of the rate of increase of the crystallisation temperature with increase of pressure near the surface; but P. W. Bridgeman has shown that the rate of increase diminishes rapidly as the pressure increases.

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[1] From the presidential address delivered to the Geological Society of London on February 19, 1926. A large portion of the address in which illustrations are drawn from the Hercynian, Wealden, and Alpine folding, and all references, are here omitted.

Allowing, then, for the fact that the temperature of crystallisation of a basaltic magma at the surface is much less than that assumed by Dr. Jeffreys, and for the lower rate of increase of the temperature of crystallisation with increasing pressures at great depths, there seems every reason to believe that a considerable portion of the cooling zone is in a non-crystalline condition, that it still contains a large proportion of volatile constituents, and that it has therefore presumably a higher coefficient of expansion than solid basalt. Nor would the substitution of a peridotite-magma, which Dr. A. Holmes believes to underlie the basalt-magma at a depth of 45 km., make any important difference.

It must be remembered, however, that, on one hand, the coefficient of expansion of all substances shows a marked increase with increased temperature, and, on the other, it diminishes with increase of pressure.

Unfortunately, we are without precise information as to the physical properties of magmas and still less as to the variations of these properties with changes of temperature and pressure. There is no insuperable obstacle to the determination of these data at temperatures and pressures up to those found at depths of about 35 miles (say, 56 km.), and they may reasonably be extended to considerably greater depths by extrapolation. In the meantime many of the problems that present themselves in geophysical research cannot be solved with any approach to certainty. It is earnestly to be hoped that a serious attempt to obtain the necessary data will be made.

There is another important consideration. In some part at least of the zone of cooling, amorphous magmatic material is passing into the crystalline state, not only as a result of the loss of heat, but also in places on account of the loss of volatile constituents. The process of crystallisation is accompanied by very considerable contraction in the case of all or nearly all silicates and mixtures of silicates, a contraction equivalent to that resulting from cooling through hundreds of degrees, whether in the amorphous or in the crystalline state.

Dr. J. A. Douglas has experimented on the increase in volume when crystalline rocks are melted and allowed to cool rapidly so as to consolidate without crystallising. The following were the results obtained with basic crystalline rocks, the composition of which approximated to that of the sima:

Name and locality of rock	Sp.g. before melting	Sp g of glass	Percentage of defect of volume in the crystalline state compared with that of the glass.
Gabbro (Carrock Fell)	2·940	2·791	5·07
Olivine-dolerite (Clee Hills)	2·889	2·775	3·95
Dolerite (Rowley Rag)	2·800	2·640	5·71
Dolerite (Whin Sill)	2·925	2·800	4·27
Average			4·75

The fourth column must represent the contraction which a glass of the same composition as the rock would undergo in crystallising. This contraction may be compared with that which would have taken place as a result of simple cooling in the crystalline state.

According to Prof. F. D. Adams, the cooling at a depth of 50 km. has been from about 1450° C. to 950° C. If, like Dr. Jeffreys, we adopt Fizeau's formula for the variation of the volume of rocks, with temperature, namely, $V_t = V_0(1 + et + e't^2)$, where V_0 is the volume at 0° C., V_t that at $t°$ C., $e = 7 \times 10^{-6}$, and $e' = 2\cdot4 \times 10^{-8}$, we find that a cubic centimetre of basic rock at 0° C. will have a volume of 1·0606 c.c. at 1450° C., and 1·0283 at 950°. The contraction in cooling from the former to the latter temperature would accordingly amount to 3·05 per cent. of the volume at the higher temperature, about 62 per cent. of the contraction in crystallisation from a melt without volatile constituents. At a depth of 100 km. the cooling is estimated to have been from about 1770° C. to about 1290° C., corresponding to a decrease in volume from 1·08756 c.c. to 1·04897 c.c., a decrease of 3·55 per cent. At 200 km. the cooling is estimated to have been from about 2200° C. to 1900° C. with a decrease from 1·1316 c.c. to 1·0994 c.c., equal to 2·84 per cent. It is evident, therefore, that the contraction on crystallisation would, even apart from the presence of volatile constituents, be much greater than from the simple cooling of crystalline material.

The steam and other volatile substances, however, are eliminated on crystallisation; consequently, the decrease in volume will be far greater than that on crystallisation from a magma without volatile constituents. The volatile constituents may afterwards occupy for a time cavities, large or small, in the consolidated rock or elsewhere in the earth's crust; but by far the greater part will sooner or later escape into the atmosphere, with a corresponding decrease of bulk of the solid earth as a whole.[2] The expulsion of volcanic materials will naturally have a similar effect.

Contraction will also occur on a change of crystalline state from lighter to denser minerals of similar composition, and not improbably on a transformation of elements into others of less atomic volume. Both these changes may be determined by the heavy pressure of the earth's interior. It is, however, probable that most of such possible changes took place early in the world's history. It is only where the pressure has for some special reason been increased or where directed pressure (shearing stress) has intervened, that such changes may be expected to have occurred during the geological time of which we have any record in the rocks.

There is, nevertheless, one change in the terrestrial conditions which will result in a general and progressive increase in pressure, and thus cause an equally general contraction. The acceleration of the moon's position in the heavens is usually considered to be in great part attributable to the slowing down of the earth's rotation. This will result in a decrease in the centrifugal force, with a consequent increase of pressure in the interior of the earth and a corresponding contraction in its volume. These effects have been calculated by R. Stonely, who arrives at the conclusion that "diminishing rotation is a much less potent cause of the elevation of mountain-ranges than is cooling, but that it is sufficiently important to be considered as a large correction to the cooling theory."

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[2] The latent heat evolved on crystallisation and changes in crystal structure must delay the processes of cooling and crystallisation, while that absorbed on the expansion of volatile constituents will accelerate them.

As I showed in my previous address, there are at least two opposing influences tending to modify the length of the day: the progressive contraction of the earth accelerating the angular velocity, and the tidal friction producing a contrary effect. At present, the latter seems to be more powerful; but it is possible that in the past the reverse has been the case, especially in the early stages of the earth's existence.

All the processes which have been considered will result in direct primary movement downwards towards the centre of the earth; but, on account of the fundamentally homogeneous character of the earth's material at deep levels (shown by the close similarity of the transmission of earthquake waves in different areas), the subsidence from this cause must everywhere be nearly the same, and will rarely result directly in appreciable *differential* vertical movements of the earth's crust.

There are, on the other hand, processes by which the surface of the earth's crust may locally be permanently extended. This can happen in regions of tension in two different ways. In the first place, temporary rifts, often of considerable size, may be filled by igneous magmas which afterwards consolidate, and by broken material from the sides and the neighbourhood. In the next place, movements of extension occur along the planes of normal faults. When, later, a period of compression supervenes, such movements will not be reversed unless the hade, the deviation from the vertical, is very great, that is to say, well over 45°; otherwise, the pressure at right angles to the fault-plane will increase the friction so much that movement will be impossible. The surface of the crust may also be increased by hydration, especially in the case of igneous rocks. These extensions of the earth's crust must in the long run tend to produce effects in the way of folding and thrusting similar to those resulting from the contraction of the interior.

There are other forces operating on the earth's crust, besides those due to the excess of the area of the crust over that of the surface of the interior, that must tend to produce horizontal movements.

In the first place, a slowing-down in the earth's rotation will be accompanied by a consequent change in the form of the solid earth, which on a large scale adjusts itself to the forces operating on it, but of course not so rapidly as do the aqueous and gaseous envelopes, though geologically the time required is relatively short.

Such a reduction of the rate of rotation of the earth will result in a decrease in the equatorial diameter and in an increase in the polar diameter, involving a movement in the substance of the earth. This will consist in a flow, at all levels, from the equatorial plane towards the poles, combined with a slight downward movement near the equator and a slight upward movement near the poles. The circumference at the equator will contract, but one must not expect contraction which is common to the surface and to all depths to have the same effect as a contraction affecting a portion of the interior, and not the exterior; and, as a matter of fact, there are no north-and-south folded mountains that can reasonably be considered to have been formed in this way. The crust at the equator would, therefore, seem not to have been folded from this cause, but to have been distorted horizontally—being contracted east and west, and extended laterally northwards and southwards. This will add to the effect of the simultaneous decrease in the meridional periphery of the earth, and a strong north-and-south compression in intermediate latitudes will result which cannot be relieved by lateral extension, except to some extent in high latitudes where there will be a small but appreciable expansion of the earth's surface.

It is, therefore, not surprising that in low to intermediate latitudes the compressive forces in the earth's crust arising from causes already discussed are intensified in a north-and-south direction so as to favour the formation of east-and-west folding.

Somewhat analogous effects would result from a change in the position of the poles relatively to the configuration of the earth's crust. This would probably be a result of the shifting of the earth's crust relatively to the core, rather than of a change of the axis of rotation of the earth as a whole from one position to another in its mass. Tidal action may result in an east-to-west movement of the earth's crust, but this alone would not directly affect the position of the pole relatively to the features of the earth's surface. But, if there were a locality such as that of a deeply-rooted mountain-mass where the cohesion between the earth's crust and the core was greater than elsewhere, there would be a tendency for the crust to rotate round it, and this would bring new tracts under the poles. There would then be a drifting-away of the continental masses from the new position of the pole on the earth's crust and towards the new position of the equator; this might appreciably affect the configuration of the earth's surface.

It has been suggested that the centre of gravity of the earth's interior does not exactly coincide with its centre of form, so that there is a point on the earth's surface where the force of gravitation is at a maximum, and towards which both the ocean waters and the continental masses tend to move. If this be the case, and the crust of the earth shifts relatively to the interior, the point of maximum gravitation will occupy a new position on the earth's crust, and the drift will be directed towards the latter.

There seems reason to believe that in late Palæozoic times the principal land-masses were united in one great continental mass collected round Africa as a centre, and that they have since drifted away eastwards, southwards, and westwards towards the centre of the Pacific. This would be only what one would expect if the points with the maximum force of gravitation were in Devonian and Carboniferous times in Central Africa, and in Tertiary and Quaternary times in the centre of the Pacific. But, although the forces, developed directly or indirectly as a result of tidal retardation and the resultant relative movement of the earth's interior and crust, must be taken into serious consideration, and may from time to time exercise decisive influence on the structure and configuration of the earth's crust, it is only the horizontal forces resulting from the contraction of the earth's interior, assisted by expansion of its crust in local and temporary regions of tension in the manner already explained, that are sufficiently powerful to account for the development of the folds and thrusts of the present mountain-chains and those that existed in former geological periods.

(*To be continued.*)

Two Oceanographical Expeditions.

I.—THE GERMAN SOUTH ATLANTIC EXPEDITION OF THE *METEOR*.

IN 1919 plans were formulated by the late Dr. Alfred Mertz for a national expedition to study the physical and chemical conditions of the South Atlantic. In conjunction with the Deutsche Seewarte at Hamburg and the Institut für Meereskunde at the University of Berlin, a very thorough programme was drawn up, a scientific staff gathered together, and the use of the gunboat 'C,' renamed *Meteor*, obtained. The vessel is of 1300 tons displacement, having a ship's company numbering 133, which includes the scientific staff of nine, exclusive of assistants, and nine ship's officers, exclusive of engineers and under-officers.

Whereas former oceanographical expeditions have been concerned very largely with the life in the oceans, the programme of this expedition is almost entirely limited to hydrographical and meteorological observations, to be made at numerous positions while crossing the South Atlantic fourteen times between the South American continent and Africa, the various positions being chosen so as to allow of the best use being made of Bjerknes' theory in calculating the currents at various levels and the consequent circulation of the water masses. Particulars of the objects, equipment and first fruits of the cruise, which commenced in January 1924, have been published by Dr. Mertz,[1] and in two later reports by Captain F. Speiss,[2] who succeeded to the leadership of the expedition after the unfortunate death of Dr. Mertz, which occurred shortly after the programme of work was commenced in the South Atlantic.

Fig. 1, taken from Captain Speiss's report, shows the tracks which have been followed and the 139 positions or stations where observations have been made at depths between surface and bottom. Besides these, numerous observations have been made at a number of other positions on the voyage out from Germany. The section from Cape Town to Buenos Aires shown in Fig. 2 indicates the nature and depths of the observations; considered in conjunction with Fig. 1 the intensity of this hydrographic survey is apparent.

With regard to the scope of observations, besides the distribution of temperature and of density, from which the probable circulation of the water in the ocean will be calculated, observations of hydrogen ion concentration, of the oxygen, carbon dioxide, gold, silver, phosphate and nitrate content of the water are provided for, and a method has been devised and used for measuring the rate of evaporation from the surface of the sea. Measurements are made of the waves encountered by a stereophotographic method, and echo-soundings are carried out by three different systems, from the results of which the production of a very complete bathymetric chart will doubtless be possible. Microplankton organisms collected at the various stations are being examined and their quantity measured on board. Regular meteorological observations are made on board and to a height of above 15 kilometres by means of pilot balloons and kites, while at the various ports visited the local geological formation has been investigated.

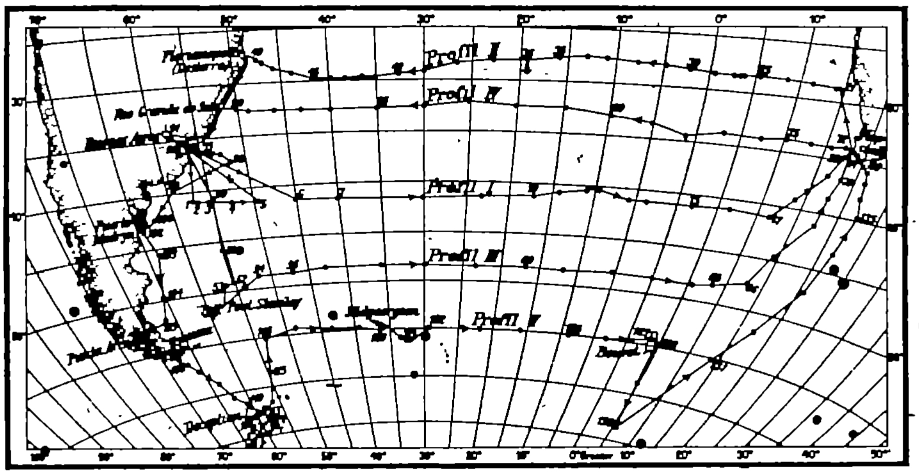

FIG. 1.—Course of the *Meteor*, with the 139 stations where observations between surface and bottom were made.

The reports give particulars of how the work is being carried out and of how it progresses according to the original plan, which the *Meteor* has been able to follow very closely in spite of bad weather experienced in the more southerly latitudes. When the observations are published and the data worked up and charted, they should present a more perfect picture of the observed conditions in this area than we have for any other ocean, and from such a survey there can be little doubt that several general principles will emerge of fundamental importance to the rapidly growing science of physical oceanography.

II.—THE CRUISES OF THE *ARMAUER HANSEN* IN THE EASTERN NORTH ATLANTIC.

For a very considerable time it has been known that the British islands owe their warm climate, in comparison with that of Newfoundland in the same latitude to the Atlantic or European current which bathes our coast, and passes northward, and to the south-westerly winds which produce it. Towards the end of the last century the Scandinavian hydrographers found that the surface temperature of the Norwegian sea varied from year to year largely in relation to the amount of warm Atlantic water which passed into it over the submarine ridge which extends from the Shetlands to Iceland. This variation in temperature in turn affected the climate and several seasonal occurrences along the Norwegian seaboard, such as the annual growth of pine trees, the time of flowering of various plants and probably the seasonal fisheries.

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[1] "Die Deutsche Atlantische Expedition auf dem Vermessungs- und Forschungsschiff *Meteor*," by Prof. Dr. A. Mertz, *Sitzungsberichte der Preuss. Akad. der Wissenschaften*, 31, 1925.

[2] "Die Deutsche Atlantische Expedition auf dem *Meteor*," *Zeit. der Gesellschaft für Erdkunde zu Berlin*, No. 1 and No. 5/6, Berlin, 1926.

As a natural result, more information was desired concerning the circulation of water in the eastern North Atlantic, and particularly of the fluctuations in the Atlantic current. Owing to the costly nature of investigations over such a wide area, the observations which it has been possible to make have been severely limited; nevertheless, considerable knowledge has been accumulated, notably through the active interest taken by Dr. Nansen. He found water of Mediterranean origin mixed with Atlantic water so far north as Ireland during an expedition made by him in 1910 in the *Frithjof*—a vessel lent for the purpose by the Norwegian Navy. In consequence of this and similar Norwegian and Danish investigations, a new set of questions were raised which made it especially desirable to carry on more extensive studies of the great Atlantic current off Europe.

In a recent publication[3] the scientific results are presented which were made during cruises of the *Armauer Hansen* in 1913, 1914, 1922, 1923 and 1924, extending so far south as Madeira and to Lat. 30° W. some 700 miles to the westward of Ireland. The ship was a small yawl of 56 tons burden, with auxiliary motor only used occasionally; that is to say, she is a vessel smaller than the trading ketches and Thames barges which ply around the British coast. The oceanographical observations were mainly made by Helland-Hansen at numerous stations to depths exceeding 2000 metres. This necessitated manœuvering the ship so that the line along which the instruments are suspended remained in a vertical position throughout the time of observations, even if there is a strong drift caused by wind or current. In this connexion they write: "Care has always been taken to make sure of the vertical position of the sounding line, and the determination of the depths may therefore be considered very trustworthy." No mention is made of the difficulties encountered in carrying out the work from the small vessel during these extensive ocean cruises, but the amount and nature of the scientific data obtained are in themselves a record of the skill, endurance and careful preparation involved. Certainly the cruises were made in summer, but nevertheless this record shows how much can be done with a small sailing vessel suitably equipped.

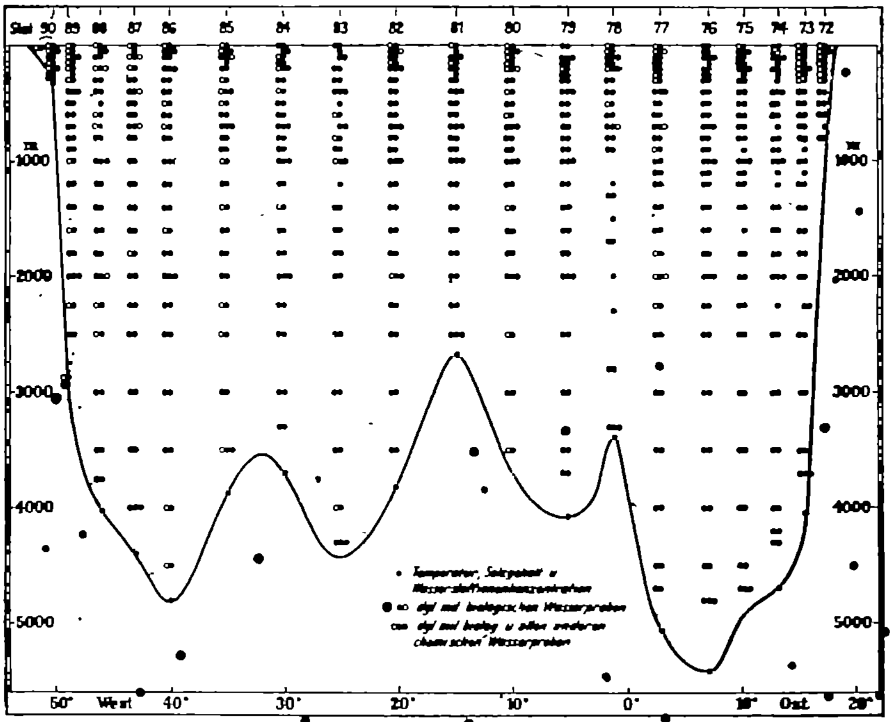

FIG. 2.—Section of the South Atlantic from Cape Town to Buenos Aires obtained from soundings by German South Atlantic Expedition in the *Meteor*.

From the density of the water, the currents were calculated for different water layers by means of Bjerknes' theory and are shown on a number of charts. These show a strong current passing eastward over the submarine bank which extends roughly north and south down the centre of the North Atlantic. This current is in about Lat. 47° N., and on arriving at Long. 25° W., a position roughly five hundred miles north of the Azores, it divides, part turning northward and north-eastward and part turning south to the Azores and Canaries, where it divides again, part turning south and part turning northeastward towards Spain. The currents immediately westward of the continental slope between Ireland and Portugal indicate a number of eddies and a more involved system than that previously supposed; however, the northerly drift of highly saline water welling out of the Mediterranean as a warm undercurrent is shown extending certainly so far as the north of Spain. The existence of these calculated currents at the various depths is based upon the assumption that the movement of water at 2000 metres depth is negligible, for which evidence is presented.

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[3] "The Eastern North Atlantic." By B. Helland-Hansen and F. Nansen, *Geofysiske Publikasjoner*, vol. 4, No. 2 (Oslo, 1926).

There has been evidence for some time pointing to vertical oscillations of the water layers at a depth of fifty metres or more below the surface in various regions of the Atlantic. This expedition has provided further evidence which indicates that the oscillations may be considerable, particularly in the deeper layers. The oscillations show a more or less regular diurnal or semidiurnal period, which suggests that they are sub-surface waves or undulations having some connexion with tidal phenomena; but how the tidal wave, producing in the open ocean oscillations of less than three feet at the surface, can produce vertical oscillations of the dimensions observed in the lower strata remains inexplicable. The desirability of further knowledge is manifest since a vertical series of observations cannot be expected always to represent the *average* conditions at any particular station; it is therefore of great importance for the discussion of the general conditions of a sea area to study how far the actual observations at the different stations and different depths may be regarded as representative.

During the course of the 1913 cruise some interesting current measurements at various depths were made from a boat moored on the bank around Rockall, an isolated rock some 200 miles north-west of Ireland. At a depth of two metres a rotary tidal stream was found, continuously varying and completely reversing in direction every six hours, a type of tidal streaming which is characteristic of the sea over isolated banks. A limited number of observations at greater depths suggest a similar variation in direction. During the fifth and sixth hours of observation a breeze sprang up and the observations indicated a wind drift of the uppermost water strata superimposed upon the tidal streaming.

Archæology of the Channel Islands.[1]

By Dr. R. R. Marett.

Though there is nothing very new to be said about the archæology of the Channel Islands, some brief notes are here brought together because well-attested facts relating to such an *angulus terrarum* are apt to escape attention. For example, in recent discussions concerning Depéret's proposed method of classifying the subdivisions of the Quaternary, namely, by giving weight primarily and chiefly to the indications afforded by ancient marine shorelines, I have come across no references to the rather striking data of this type provided by the islands (see, for example, my summary account of them in *Archæologia*, 62, 469-80). Thus, one Jersey cave, La Cotte de St. Ouen, exhibits a Mousterian industry with cordiform 'points,' *i.e.* belonging to a phase that is not the latest, as resting more or less directly on a marine deposit of sand and rolled pebbles forming the floor-bed of a cave at about 20 metres above present mean tide-level. On the other hand, another cave in Jersey, La Cotte de St. Brelade, contained the remains of a copious fauna, mammoth, woolly rhinoceros, reindeer, etc., conjoined with the later of two well-represented phases of the Mousterian industry; from which fact it is fairly safe to argue that Jersey was then freely accessible from more spacious lands.

Here, then, is almost crucial evidence that the later Mousterian culture coincided with a period of land elevation preceded by one of subsidence (to use such terms without prejudice to the question whether sea or land was the active factor responsible for the change of level). This would accord well enough with Depéret's Monastirian stage with its 20-metre shoreline marking the downward movement (from the point of view of a man as contrasted with that of a fish) and a later oscillation of at least a like extent in the opposite or upward direction; exactly 20-metres in the way of land elevation being at present necessary to render Jersey accessible from the Continent at low tide. Of previous changes of sea-level it must suffice here to say that at Le Cané de la Rivière, on the north coast of Jersey, there is clear evidence that the sea had time to hollow out a cave at the 10-metre level before it rose to 20 metres and plastered the sides and top of the cave in question with beach-pebbles. Still earlier, one may presume, is a solitary deposit of such pebbles at South Hill at a height of about 45 metres. Unfortunately, these various raised beaches contain no shell whereby to correlate them with Depéret's palæontological series.

When, on the other hand, we turn to post-Mousterian evidence of change of level, a section taken almost anywhere in the valley-bottom on which the town of St. Helier's stands (the level being about 10 metres above O.D.), reveals with remarkable uniformity beneath a few feet of modern alluvium, two peat-beds alternating with two underlying marine layers of sand and shells. In the upper peat-bed a mould for a spear-head has been found, giving it a Bronze Age horizon. From the lower peat have come several rough sherds, one characteristically decorated with punctured dots in rows, that proclaim the horizon Neolithic. Moreover, there can be little doubt that this lower peat-bed is to be correlated with the submerged forest so well in evidence round the islands down to low-tide level and beyond it, as notably at Vazon Bay in Guernsey, whence proof of Neolithic age is also forthcoming. Considerable land-elevation in this region in Neolithic times is thus indicated.

How far these facts have a bearing on the general history of the Channel is hard to say. As for Jersey in particular, its position at the end of a narrow spit of the Continental shelf running westward between depressions hollowed out by ancient rivers would naturally impart to the island a certain tendency to isostatic movement of a more or less local character. Even so its oscillations are so sharply defined, and can be so closely correlated at several points with the archæological series, that they deserve more notice than they have got. If experts from England would face certain other oscillations likely to be encountered on the way across channel, they would be met both with a hearty welcome and with much to puzzle over.

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[1] Substance of three lectures delivered at the Royal Institution on Nov. 18, 25, and Dec. 2.

As for the Palæolithic record of the islands, nothing of great importance has hitherto come to light apart from the two Mousterian caves already mentioned. The Lower Palæolithic is barely represented by sporadic implements of rather nondescript and doubtful type Rough flints, in which some see signs of human workmanship, have been recovered from the clay capping certain rocks now disjoined from the land; and there can be little doubt that this clay is an æolian deposit of pleistocene age if only because it is distributed impartially between land surfaces of very various elevation. This loess, however, as it may be termed, affords no precise criterion of the age of the associated artefacts (if such they be) since it must have been forming steadily throughout the Ice Age. It is to be noted, by the way, that it extends some way below the present sea-floor, and must therefore have been in part laid down during a time of land-elevation.

Of the Mousterian caves, and more especially of La Cotte de St. Brelade, with its teeth of Neanderthal man, its fauna amounting to nearly forty species, and its flint implements of more than 5000 well-shaped pieces, with as many more showing signs of use, much might be said. Perhaps the most interesting result obtained from the latter site was the clear proof of two occupations separated by a considerable gap of time; a fact which, so far as it goes, would support the Abbé Breuil's recent attempt (*Man*, Oct. 1926) to establish a very long duration for the Mousterian

The Lower Mousterian, associated with an elephant certainly not mammoth and provisionally identified by the late Dr. C. Andrews with *E. trogontherii*, occurred in four feet of indurated breccia, and was characterised by heavy coarse flakes and at least one core-implement. I could not on my own responsibility identify it with the horizon of La Micoque, but should welcome further light on the typological question. Above the breccia occurred a uniform layer, about a foot thick, of fine cave dust, and this bed was quite sterile. Evidently the cave was deserted by man for a very appreciable interval—long enough, in fact, for the fauna to have changed. Above it came six feet of loose rock rubbish, mixed with a light loam, and here occurred a large number of highly finished and beautiful implements of Upper Mousterian type associated with mammoth. The whole was sealed by a thick bed of banded lemming (*Dicrostonyx torquatus*), over which lay 30 feet of sterile clay and rock-rubbish of the type known as 'head.' Finally, the Upper Palæolithic is represented if at all by a well-marked industry occurring in several sites (mostly shallow deposits of peaty soil along the cliffs), which shows a predominance of small blade-like tools, in which a typologist might possibly discover Magdalenian affinities. In association with these has been found a needle which, if made of ivory, as seems to be the case, and not of bone, would decisively fix the horizon as Palæolithic.

Passing on to later times, one may speak comprehensively of the Megalithic period without prejudice to the question whether the monuments with which the islands teem are Neolithic in the sense of belonging to an age when, regionally at all events, polished stone without metal was in use, or are wholly or partly assignable to the Bronze Age. Nay, it may be just worth noticing that one Jersey passage-grave, Mont Ubé, contained specimens of the *pic* and the *tranchet* (figured by me in *Archæologia*, 63, 226), which look like survivals from a previous era, namely, the Campigny period. On the other hand, there are no signs of a local development (such as has been assumed both for the Iberian Peninsula and for Scandinavia) from the true dolmen with a single capstone; but seemingly the full-fledged passage-grave was introduced at the outset. Perhaps the term 'passage-grave' should, however, be reserved for the type of monument consisting in a narrow passage leading into a wider sepulchral chamber, the whole covered by a round tumulus. This, indeed, is the normal structure found in the islands, as also in Brittany and Iberia; but Mr. T. D. Kendrick in "The Axe Age" (Methuen, 1926) has directed attention to two *allées couvertes*, or 'cists,' as he prefers to call them, which he believes to be non-western in character. These are Le Couperon and Ville ès Nouaux in Jersey, both monuments showing the remains of peristaliths which suggest that they were surmounted by long barrows and not by circular mounds.

At Le Couperon occurs a 'port-hole' slab, a fact which affords Mr Kendrick further reason for suggesting eastern influences, proceeding proximately from the Paris basin. In this connexion he likewise points to the complete resemblance between the statue-menhir of the Câtel, Guernsey, with its necklace and closely juxtaposed breasts carved boldly in the round, and certain wall-carvings adorning the cists of the Seine and Oise valleys. Meanwhile, it should be noted that if Ville ès Nouaux be of eastern type as regards structure, it nevertheless contained grave furniture of markedly western pattern such as bell-beakers—a fact chronologically interesting as proving that the cist culture had arrived before the beaker ceased to be in fashion. Further, as regards ceramic, several Jersey passage-graves have yielded a peculiar type of cup-like vessel with a hollow base and characteristic decoration; and some half a dozen more of these in excellent preservation have been found in the newly opened monument of La Hougue Bie. French archæologists have sometimes labelled this type 'supports,' as if other round-bottomed vessels had originally been set up upon them; but it is at least equally likely that they were self-sufficing receptacles of food-offerings to the dead. In any case, more important than the question of their function is that of their bearing on the origins of the megalithic culture-complex as met with in the islands. To judge by the distribution of the very few examples hitherto noticed in France, it would seem that this peculiar ceramic marks the track of a culture coming from east-central France down the Loire valley, probably at some time early in the Bronze Age, and thence turning northwards to Brittany and the islands.

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Much might be said about the life of this period as deduced not only from the megaliths but also from humbler remains, such as notably the graves, with the associated cairn and midden of the islet of La Motte, Jersey—to which, by the way, the little island of Thinic, to the west of the peninsula of Quiberon, seems to offer a close parallel (see *Archæologia*, 63, 210).

It must be enough, however, in conclusion to direct attention to two megalithic monuments of special interest. One of these intrigued the dilettanti of the eighteenth century; and Horace Walpole's friend, Marshal Conway, actually removed it in 1787, two years after its discovery in Jersey, to Park Place, Henley, where no British archæologist should fail to pay it a visit. It is in several respects unique among island monuments. For one thing, the covered passage leads into an *enceinte* which is perfectly circular, unlike the normal passage-grave, which is shaped more like a tennis racquet than a jew's-harp. Mr. Reginald Smith (*Proc. Soc. Antiq.*, 1919, 143) compares the shape of a neolithic house with covered passage found at Pléneuf, Côtes-du-Nord. A similar house has recently been discovered at La Sergenté, Jersey. Again, the *enceinte* with its six trilithons, somewhat suggestive of a miniature Stonehenge, may well have been hypæthral as at first designed, though later by design or accident a mound of earth (or blown sand) was superimposed. As for the magnificent passage-grave of La Hougue Bie excavated in 1925, though doubtless its contents were disturbed at some time, it remains in the intact majesty of its structure a very masterpiece of art, unsurpassed whether in size or in the symmetry of its design by any monument of the kind in north-western Europe.[2]

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[2] On the whole subject see three papers by the lecturer in *Archæologia*, vols. 62, 63, 67, and for full details the *Bulletins de la Société Jersiaise* and *Proceedings of the Guernsey Soc. of Nat. Hist.*, later La Société Guernesiaise.

News and Views.

WITH this issue we begin the publication of a weekly "Calendar of Discovery and Invention," in which, so far as possible, each day will be used to recall some event of importance in the history of science and its application. The notes are being compiled by Engineer Capt. Edgar C. Smith, of the Science Museum, South Kensington, who some years ago contributed to our columns the Calendars of Scientific and Industrial Pioneers. It is not to be expected that every event of importance in the history of science will be referred to; such would be clearly impossible within the limits of a weekly column in a year's issue of NATURE. It is also obvious, from the nature of the records available, that the physical sciences and engineering are likely to figure in the column more than the biological sciences, medicine, and similar subjects, in which it is often difficult to assign the announcement of a discovery to a particular day. Suggestions regarding events suitable for inclusion in the column will be welcomed.

BY invitation of the French Government, a meeting of the executive council of the International Institute of African Languages and Culture was held in Paris on Monday, December 13, instead of in London, as had been previously arranged. It was thus the first to be held outside England, and with it the work of the Institute, which was founded a little over a year ago, may be considered to be fairly launched. The initial difficulty of raising funds, it may be hoped, is well on the way to solution, especially as it was announced at this meeting that the Government of the Gold Coast has promised a donation of £500 a year for the next two years. It is to be hoped that this subsidy will be renewed at the end of that period, and that the example of the Gold Coast will be followed by other African dependencies, as well as by organisations and individuals interested in Africa and African studies. The programme already mapped out by the Institute covers most important fields of research, and its work of co-ordination in the study of African linguistics and ethnology will be especially valuable in promoting the development and education of the African native.

THE meeting was attended by representatives of Great Britain, France, Germany, Austria, and other countries. Among those present were Dr. Westermann, the distinguished German authority on African languages; Sir Frederick Lugard; Major H. Vischer of the British Colonial Office, to whose efforts the foundation of the Institute are largely due; and the Rev. E. W. Smith. Prof. Seligman, who represents the Royal Anthropological Institute in the Institute of African Languages and Culture, was unfortunately unable to attend. M. Labouret of the French Colonial Office was appointed joint Director of the Institute in succession to M. Delafosse, the announcement of whose death was received with much regret. A deputation of the delegates was received by M. Perrier, French Minister for the Colonies, who expressed great interest in the work of the Institute.

AT a meeting of the Newcomen Society on December 15, papers were read on two famous Swedish engineers. The first paper, by Mr. J. G. A. Rhodin, was on Kristofer Polhammer, better known as Polhem, the name he took on being ennobled. Polhem was born in 1661 and died in 1751. Starting as a clerk on an estate, he was enabled to study science at Upsala, and became a mining engineer at Stora Kopparberget, where he built his famous "Machina Nova," a large water-driven headgear for handling the ore. His inventions relating to mining and metal working were numerous. He also made the dock gates for the dry docks at Carlskrona, then the largest in the world, and built the lock at Stockholm uniting the Malar Lake with the Baltic. He also began a system of locks to make the Trolhattan falls passable, but the work was discontinued on account of the death of Charles XII. Mr. Rhodin described Polhem as "one of the first engineers in this world with a thorough theoretical training, yet practical to a degree in spite of his bringing up at *Alma Mater Upsaliensis*."

THE second paper read before the Newcomen Society on December 15 was the outcome of a translation of the book by Triewald on the "Fire and Air Machine at Dannemora," undertaken by Mr. Are Waerland for the Newcomen Society. Triewald lived in England about ten years, was familiar with Newcomen, erected a Newcomen engine near Newcastle, and built the first steam-engine used in Sweden. His book contains the first complete description of the atmospheric engine of Newcomen, and is therefore of special interest to the Society. It is hoped to publish the English translation. Like many men of his time, Martin Triewald wrote on a great variety of subjects. Born in 1691, he early engaged in business, but becoming bankrupt, at the age of twenty-five years he came to England. He was befriended by the Dutch Minister and attended the lectures of Desagulier, became known to Newton, and then found employment with Ridley of Newcastle as an engineer. At the age of thirty-five years he returned to Sweden and at Dannemora built his great engine. He afterwards held various Government appointments, was the first to introduce the experimental methods of science into Sweden, and was one of the six founders of the Royal Swedish Academy of Sciences. He died in 1747. At the University of Lund is a fine collection of scientific apparatus collected by Triewald and used by him for his lectures.

To the panoramas illustrating various parts of the British Empire, several of which were brought to the Imperial Institute from the Wembley Exhibition, the Director, Sir William Furse, has recently added two. One, in the Falkland Islands Court, represents a whale, off the coast of South Georgia, being harpooned by a 'chaser' fitted with a modern harpoon gun. The mother ship, where the carcase will be cut up, is not shown in the picture. The sea is cleverly modelled and looks well from a distance, but on a nearer view betrays its plaster composition too obviously. It is a question whether the visitor should not be prevented from coming too close. In this, as in the previous models, the horizontal plane is tilted up, like the stage of a theatre, so that the line of sight approaches it at a greater angle than natural conditions usually permit. The evident advantage would be attained in a less forced and less perplexing manner if the models were placed a little lower.

THE other model referred to above depicts wild animal life in Tanganyika. The twin peaks of Kilimanjaro rise in the distance, while over a richly diversified foreground are scattered various members of the fauna, from monkeys and lions down to crocodiles and snakes. The exhibit is designed and executed by D. Y. R. Furse and R. T. Roussel for McCorquodale and Co., and we are told that most of the animals have been modelled by an artist who has almost daily acquaintance with them on his farm in East Africa. Even he, however, can scarcely have seen all these creatures at once. This familiar defect of such panoramas is to some extent remedied by the large extent of country shown in a width of about six feet and the small scale of the animal models. These in themselves are characteristic enough, but the same can scarcely be said of the flora. All the trees and shrubs are made of a curious material which looks like the skeleton of some antipatharian or gorgonid coral. If this really is the case, we may at least suggest that the needed variety might have been attained by using more than one species. The Director's attempts to interest the public by these models are heartily to be commended, but one has to guard against giving false impressions.

THE Institution of Chemical Engineers held a very successful conference on December 8-10 in the Science Museum, South Kensington, the subjects discussed including the measurement of mechanical power absorbed by driven machines, the uses and limitations of statistics in industry, air elutriation, and refrigeration. Although a few of the papers could be classed as specifically chemical, most of them introduced chemical subject matter by way of illustration. The practice of holding conferences at which a number of papers are read, appears to be growing in Great Britain. Multiple programmes have the advantage of making it worth while for country members to travel long distances, so that meetings are larger and colleagues are more certain of seeing one another. Secretarial work is also more concentrated and therefore more economical. On the other hand, papers are apt to crowd one another out, and discussions are thereby curtailed.

MESSRS. R. G. Parker and D. N. Jackman described a new form of recording torsion-dynamometer of the type that does not itself convey power, but is applied to a transmitting shaft. Such a shaft is very slightly twisted, and the twist, which is proportional to the power, is measured, the readings being recorded photographically. In a symposium on statistical methods in relation to industrial efficiency, Messrs. D. Ryder and T. C. Finlayson dealt with the control of chemical-plant operation by this method, mainly from the point of view of the works manager. The points discussed included the transference of material, production, reports by shift foremen, the plant manager, the engineer, and the laboratory; also the methods used by the statistical office in summarising the data concerning production, labour, and stocks. In his paper on some uses and limitations of statistics in industry, Mr. H. C. Marris deplored the paucity of statistical material for forecasting short-term trade movements.

ON the third day of the conference, Dr. Geoffrey Martin contributed a paper on the laws of air elutriation, pointing out that Stokes's law applies only for very small particles, and advancing other generalisations for particles of larger size. He emphasised the influence of temperature on particle size, and expressed the view that there is great scope for research on the influence of particle-shape on lifting power. The concluding paper, on refrigeration in the chemical industry, by Mr. H. M. Dunkerley, contained many details concerning the construction of refrigerating plant and useful data on costs of the process. As the result of the study of a large number of installations of different types, he concludes that their capital cost ranges from £70 per 10,000 B.T.U. per hour for plants with a capacity of 250,000 B.T.U. per hour, to £50 for plants with a capacity of 2-3 million B.T.U. per hour.

FURTHER official information on "The Wet November of 1926" is given in the *Meteorological Magazine* for December. The total for the month was above the average everywhere over the British Isles except along the north-west, north, and north-east coasts of Scotland. The excesses were largest in the south-west of England and Wales and in Connemara. More than twice the average was recorded in these areas as well as at Wetherby in Yorkshire and at Dundee. Falls of more than 250 per cent. of the average occurred in parts of Dorset, Hampshire, and Hereford, while at Ross the fall of 7·87 in. was so much as 311 per cent. of the average. The largest monthly totals were those reported from Llyn Llydaw on Snowdon of 19·50 in., and from Delphi in Connemara of 18·50 in. More than 5 in. of rain was recorded in one day, in Snowdonia on November 4 and in Connemara on November 18. At Camden Square the number of days of rain, 25, and the duration of rainfall, 85 hours, were the largest in November since records commenced, in 1858 and 1881 respectively. It was the wettest November over the British Isles as a whole.

IN order to illustrate some of the recent advances that have been achieved in British-made microscope object-glasses, Messrs. R. and J. Beck, Ltd., of 69 Mortimer Street, London, W.1, recently gave a demonstration of the results obtainable from apochromatic object-glasses of their own manufacture. During the past five years these lenses have been completely redesigned, and a method of testing by zones to the extreme margin has been introduced, with the result that the resolving power of the lenses attains the theoretical limit for their respective apertures. The specimens exhibited included a ⅔-in. apochromat, 0·35 n.a., resolving the dots in *Pleurosigma formosum* (dot interspaces about 36,000 per in.); a ¼-in. apochromat showing resolution in dots in *Navicula rhomboides* (about 66,000 lines per inch); the resolution in dots of the *Amphipleura lindheimerii*, *styrax* (about 90,000 per inch), by a ⅙-in. apochromat, 0·95 n.a., the theoretical resolving power being about 95,000 lines per inch; and the resolution of dots in *Amphipleura pellucida* (about 130,000 per inch) by a $\frac{1}{12}$-in. oil-immersion apochromat, 1·4 n.a., with a theoretical resolving power of about 140,000 lines per inch. Demonstrations were also given of methods of testing the general quality of an object-glass. These included the use of a podura scale, which is a good test of the central zones of a high-power object-glass, and of a silver film with pinholes, which provides also a sensitive method of adjusting the tube length to suit the objective. In the series of experiments dealing with illumination, the most interesting was one showing a portion of a diatom overhanging the strip on which it was mounted. While the image of the portion supported and covered by glass was obliterated by glare caused by multiple reflections from the glass surfaces, there was good resolution and complete absence of glare where there was no cover glass or slip.

THE Wellcome Bureau of Scientific Research and Museum of Medical Science, situated at 25-28 Endsleigh Gardens, London, have recently been enlarged, and we received, on the occasion of their reopening by the Minister of Health, a profusely illustrated booklet giving an account of the work of the Bureau and its affiliated institutions, the Entomological Field Laboratory and the Physiological and Chemical Research Laboratories, together with a description of the contents of the Museum. There are also included lists of the papers published from the Bureau and the research laboratories from their foundation to the present time. The Museum of Medical Science is arranged to afford a continuous demonstration of various diseases, their causes, effects, and treatment, so as to give a graphic picture of the more important features. On the ground floor are arranged exhibits of the diseases caused by the Metazoa, venomous beasts, insects, worms, etc. The first floor is devoted to diseases caused by protozoa and spirochætes, and a special section is given to leprosy and tuberculosis. The second floor has as its exhibit the diseases caused by bacteria, including the exanthemata, whilst the third floor demonstrates dietetic, metabolic, and blood diseases, a section being also given to new growths. The Bureau does no routine teaching, but is open to individual workers who wish to follow some particular line of investigation. The Museum is open to all medical men, health officers and students, and is available to teachers of medicine for the purpose of giving demonstrations to their classes.

WE learn from the *Bell Laboratories Record* that the John Scott medal, founded in 1816 by John Scott of Edinburgh and awarded from time to time by the Board of City Trusts of Philadelphia for outstanding inventions, has been awarded to Gustaf Waldemar Elmen for his invention of permalloy. This nickel-iron alloy, which is noteworthy for its high permeability for minute magnetising force, is widely used in transformer cores, certain telephone receivers, and in 'loading' submarine telegraph cables for high-speed transmission.

SHORTLY after the s.s. *William Scoresby* sailed from Hull to join the *Discovery*, the house magazine of Messrs. Reckitt and Sons published an account of those celebrated whalers and explorers, the Scoresbys. It was illustrated from one of the original log-books and other material in the Fisheries Museum at Hull, and Mr. Sheppard has now included it in the 'Record of Additions' to the Hull Museum, No. 69.

THE late Prof. R. Klebs, of Konigsberg, who was the most distinguished student of the insects included in Baltic amber, himself formed a large collection of such objects. A large number of his specimens was purchased by the Trustees of the British Museum in

1892 to enrich the extensive national collection of *inclusa*; but he left to his heirs a still larger collection containing many specimens of historic importance. We are glad to learn that this collection has not been dispersed, but that it has been found possible to purchase it for the Geological Institute of the University of Konigsberg, which already possesses a famous cabinet of these objects. Properly qualified research workers will now, as in the past, be accorded the utmost facilities for the study of these great collections.

MESSRS. Harold C. Urey and Arthur E. Ruark, writing from the Johns Hopkins University, Baltimore, Maryland, state that they are preparing a book of about 700 pages on atomic and molecular structure, embracing both the theoretical and experimental aspects of the subject, and that they will be glad to receive reprints of private communications as to results not yet published.

MESSRS. C. Baker, 244 High Holborn, London, W.C.1, have prepared a new issue (No. 88) of their Classified List of Second-Hand Scientific Instruments. The catalogue is divided into sections dealing with microscope apparatus, surveying, astronomical and other instruments, spectroscopes, physical apparatus, and so on. The present list contains offers of a number of students' microscopes and accessories, while the astronomical telescope section is also large and its contents varied. Among the larger instruments is an 8-in. Cooke equatorial which was the property of the late Dr. W. H. Maw. Surveying instruments, and field glasses and small telescopes are let out on hire. Nine volumes of NATURE (1885–1890) are also offered for sale.

MR. GEORGE C. SHERRIN has designed, and Messrs. George Philip and Son, Ltd., have produced, a set of apparatus for demonstrating popular experiments in dynamics (20*s*. net). The set is supplied in a wooden box and is accompanied by an illustrated handbook. The apparatus consists of nothing more than a series of small steel rods of varying thickness, of weights, pivots, and collars, the parts being assembled in much the same way as the parts of a 'meccano' outfit. The result is to produce a toy capable of demonstrating—and that very effectively—the relative movements of earth, moon, and sun, the action of centrifugal force, various gyroscopic effects, and the principle of Foucault's pendulum. In itself, this is no mean achievement for such a simple toy, but in reality its 'star' turn is intended to show the action of the Flettner rotary cylinder. If a criticism might be levelled against such a delightful toy for grown-ups, it is that the last demonstration fails to carry complete conviction, first because an artificial wind created by blowing from the mouth cannot be relied on to strike a moving rotating cylinder accurately in a specified direction, and secondly, the deviations from accuracy in this respect may themselves produce the actual effects to be observed. If the toy is to rank as a piece of scientific apparatus, certain of the parts will require to be more delicately made.

Our Astronomical Column.

OBSERVATIONS OF PROXIMA.—Union Observatory Circular, No. 70, contains some interesting notes on this star by Mr. Innes and Dr. van den Bos. The colour is orange or orange-red, the spectrum probably *K*, the visual magnitude 11·2, the photographic 13·0. The parallax is given as 0″·90, which is larger than that deduced from the assumption that parallaxes and proper motions are proportional when compared with α-Centauri. Dr. van den Bos makes the interesting, but rather improbable, suggestion that the sun, Proxima, and α-Centauri form a straight-line solution of the three body problem. The parallax of the centre of gravity of the system would be 1″·14. It is satisfactory that Dr. Alden will investigate the parallax of Proxima with the Yale Telescope at Johannesburg.

THE SOLAR PHYSICS OBSERVATORY, CAMBRIDGE.—The thirteenth annual report of the Director of the Solar Physics Observatory, Cambridge, has recently been received, describing the stellar and solar work carried out at the observatory during the preceding year. Amongst the published work on stellar spectroscopy, mention may be made of a paper by Mr. Baxandall on absorption lines in spectra of types *G*, *K*, and *M*. The wave-lengths, intensities, and probable origins of lines in typical spectra of these classes have been determined and compared, in order to investigate the nature of the changes that occur in this region of the stellar sequence. Preliminary experimental work is being done by Mr. Carroll on the photography of the extreme red region by means of hypersensitised panchromatic plates, and also in testing the theoretical effect of stellar rotation upon absorption lines by studying the same effect in the solar spectrum. In the department of solar physics, an important piece of work (begun in 1916) has now been completed by Mr. Baxandall in revising the chemical origins of Fraunhofer lines in Rowland's tables. This work has been completed for the region λλ3900-5900, and the results sent to Mount Wilson for incorporation in a revision of Rowland's tables by the International Astronomical Union. Spectroheliograms of the sun's disc have been obtained on 118 days, and these, augmented by 326 spectroheliograms from Kodaikanal, have been studied by Mr. Butler. An investigation by the Director, assisted by Mrs. Beech, on the distribution of outbursts of sunspots, now covers four complete 11-year cycles, and a summary of the results is being prepared.

THE DISTANT COMPANION OF CASTOR.—An interesting article in the *Scientific American* (December) by Prof. H. N. Russell, describes recent researches on this star. A few years ago Messrs. Adams and Joy at Mt. Wilson found that it is a spectroscopic binary (as are the bright components of Castor) with a period of 19 hours 32 minutes. Dr. van Gent, of Leyden, finds that partial eclipses of each component by the other occur at intervals of 9^h 46^m. Their distance apart is 1,600,000 miles, and each is 520,000 miles in diameter. The mass of each is 0·52 sun, and the density 2·5 sun, or 3·5 water. It is the greatest density found for a spectroscopic binary. The total light of each is $\frac{1}{30}$ of the sun's, and the surface brightness $\frac{1}{11}$ of the sun's. The concluded surface temperature is 3500° C., in good accord with the *M* type of spectrum which was found for them. It is of great interest and importance to have these accurate details of a pair of typical dwarf stars.

Research Items.

West Indian Stone Collars.—An interesting suggestion relating to the origin of the 'stone-collars,' which are a problem in West Indian archæology, is made by Mr. A. D. Russell in *Man* for December. The collar stone is an object in shape much like a horse collar, but obviously too small for that purpose, and unsymmetrical in shape, being bent to one side at the narrower end. Various theories as to their origin have been put forward. Mr. T. A. Joyce has suggested that a wooden mechanism is indicated, two unequal ends of the fork of a tree being bent round and fastened together, the part of the tree cut off below the fork being represented by the protuberance called by some archæologists the 'shoulder.' It is here suggested that this wooden mechanism was a tree climber, which is symbolised by the stone collar. This might more accurately be termed a belt or cincture. The palm climber of West Africa and the West Indies, with which the collar is compared, is made in two pieces. Two lengths of supple wood are bent into a long oval hoop, the two ends on the right side being secured by a permanent fastening, those on the left being done up and undone as need requires. The identity of the palm climber in West Africa and the West Indies is scarcely to be explained as introduced by the slave trade, since the archaic stone collar proves its existence in the latter area before slaves were introduced.

Mohammedan Child-killing Demons.—In *Man* for November, Mr. W. Ivanow points out that Persia has preserved under a Mohammedan cloak many customs and beliefs descended from a remote antiquity. A great deal of this material is to be found in the literature and, especially, in manuscripts. In support of this, extracts are given from a rare medical treatise, written at Delhi in 1876, which reveals some peculiar beliefs relating to the supernatural malevolent beings causing death or harm to young children. The work is called "The Comfort of Man," the author being Abdu'l-Qawi ibn Shihábi'd-din, surnamed Ziya. All evil beings are divided into five classes. The vampires attacking children belong to the fifth class of *divs* and *peris*. Of these there are two divisions, shapeshifters or were-hyænas (*Kaftár*) and Ummu's-sibyan, called in Arabic "the mother of children," probably an ancient conception of the spirit causing the premature death of new-born babes: apparently Lilith, the Lamia, or the Strigil. According to Ziya she is the mother of devils and has seventy-five baby-*divs* at her breast. When a woman gives birth she may, if not watched, substitute a *div* for the human child. Burnt hair from the back of a black cat will drive her away. The *Kaftár* or hyæna, a rare animal in Persia, seems to imply a witch, but it has not much connexion with lycanthropic ideas. References to it are rare in Persian literature, and it is doubtful if the belief survives among the people to-day, unless it is under another name.

Spermatogenesis in the Mouse and the Rabbit.—K. Masui (*Jour. Coll. Agr.*, Imp. Univ. Tokyo, 8, No. 2, 1923, just received) undertook a reinvestigation of the spermatogenesis of the mouse and of the rabbit, chiefly with the purpose of studying the chromosomes. Measurements of the spermatogonial chromosomes show that these are in pairs and that there is a constant relation between their size and their form. Two special chromosomes are probably the sex chromosomes. The observed variation (44 to 54) in the number of chromosomes in the rabbit is attributed to the fragmentation of certain chromosomes caused by the fixation. The diploid number in the mouse is 40. The conjugation of the chromosomes probably takes place by telosynapsis in the mouse and by parasynapsis in the rabbit. From the behaviour of the sex chromosomes it is suggested that dimorphism of the sperm results. The mitochondrial granules do not originate from the nucleus in the early stages of the spermatocyte, but exist in the cytoplasm from the beginning.

Phylogeny and Classification.—In an extended discussion of phylogeny and the natural system, Dr. W. B. Crow (*Jour. of Genetics*, vol. 17, No. 2) reviews the various conceptions of phylogeny and their relation to classification. He covers a wide field of reference with relation to plants and animals, but occasionally betrays an inadequate first-hand acquaintance with the various interpretations placed upon the variations he is discussing. His paper serves, nevertheless, to focus attention afresh upon phylogenetic problems. He points out the inadequacy of causal morphology without an historical background to explain the problems of relationships, and shows, *e.g.*, that there are good reasons for concluding that such a simple colonial form as Pleurococcus has been derived by reduction from filamentous ancestors. He emphasises the principle of Cope, that in tracing the descent of genera, purely specific characters should not be taken into account, and similarly concludes that, in tracing the phylogeny of species, no account should be taken of the genealogy of individuals. This leads to a discussion of Mendelism from a phylogenetic point of view, and the recognition that the genealogy of gametes has its bearing on the phylogeny of characters.

Tertiary Shells from Japan.—A number of fossil mollusca and brachiopoda from beds in the island of Sado, off the coast of Echigo, Japan, have been described by Prof. Matajiro Yokoyama (*Jour. Fac. Sci.*, Imp. Univ. Tokyo, Sect. 11, Geol., etc., vol. 1). These fossils come from the Sawané formation, and the author concludes that their geological horizon corresponds to the Musashino (Pliocene) of the neighbourhood of Tokyo. Following the few "general remarks" and table of distribution, the paper consists of descriptions of 149 species of mollusca and brachiopoda, including a goodly number believed to be new and figured on the six accompanying plates. There is also a good index.

Marine Shells of the W. Coast of N. America.—The first volume of what promises to be a most important manual on "The Marine Shells of the West Coast of North America" (*i.e.* Canada and the United States, but not Mexico), dated 1924, has only just reached us. It is published by the Stanford University and in somewhat Gilbertian manner forms No. 1, vol. 1, of the "Geological Sciences" series, and has been compiled by Mrs. Ida S. Oldroyd, the Curator of the Geological Museum. When completed the work will cover in extended form the same ground occupied by the 'Summary' by Dr. Dall, issued in 1921 (*U.S. Nat. Mus. Bulletin*, 112) with the addition of the Brachiopoda. The classification followed, though not so stated, is that of the same veteran conchologist, first proposed in 1895 (*Trans. Wagner Free Instit.*, vol. 3, No. 3). The major divisions above genera are not defined, but each genus is, while with each species is given the original reference and description, supplemented where necessary from other sources, followed by the citation of the type and type locality, with its 'distribution' (or 'range' as alternative term) and 'range in time.'

It is stated that some new species described by Dr. Bartsch are included, but apparently not in the present volume, which deals only with the Pelecypoda and Brachiopoda. To the 247 pages of text there are appended 57 plates of unequal merit that do not proportionately enhance the value of the volume, while the individual members of a genus, instead of being figured together, are peppered indiscriminately among the plates, sometimes widely apart. The task of bringing together this mass of material must have been enormous, and Mrs. Oldroyd will receive the cordial thanks of all fellow-workers, who will impatiently await the issue of the further volumes.

ISOSTASY IN SPAIN.—A recent report on the isostatic reduction of gravity stations in Spain (*Mem. del Inst. Geog. y Cadastral*, Madrid, vol. 15, 1926) is summarised and commented upon by W. Bowie in the *Am. Jour. Sci.* for October 1926. The computations were made by the U.S. Coast and Geodetic Survey. The method of least squares shows that the most probable depth of compensation is 96 km. as in the United States. The average anomalies are + 0·011 with regard to sign and 0·032 without regard to sign, the corresponding United States figures being - 0·006 and 0·021 respectively. It is noteworthy, in looking for an explanation of the residual anomalies, that the Spanish stations on pre-Cambrian formations give an average anomaly of + 0·047, while those on Tertiary formations give - 0·033. Anomalies have also been computed for depths of compensation ranging from 56·9 km. to 184·6 km. Very little difference was revealed by the results, except for the greater depths where the larger anomalies became exaggerated and nearly all became positive. The recent tendency towards adopting a smaller depth of compensation than those formerly advocated thus receives support.

ISOLATION OF ELEMENT 61.—Since the appearance of a preliminary note on the independent isolation by Rolla and Fernandes of element 61, mentioned in NATURE, December 4, 1926, p. 820, we have received a fuller account of their investigation in the September issue of the *Gazzetta Chimica Italiana*. The paper contains diagrams of spectra and a chart illustrating the long series of fractional crystallisations to which the didymium earth was submitted. Among the peculiarities displayed by the absorption spectra of the extreme fractions may be mentioned the strong absorption bands in the yellow, attributed up to now to neodymium, which by dilution of the solution are divided up into numerous lines having for the various fractions very diverse relative intensities. The peculiarities of these fractions are identical with those which are attributed to the presence of element 61.

PROPERTIES OF ACETONE.—Some accurate values for the vapour pressures and densities of acetone from about - 80° to + 60° appear in the *Journal of the American Chemical Society* for November. These are intended to replace the existing data, among which considerable discordance is noted. The determinations were carried out by Felsing and Durban in calibrated apparatus to which the acetone, purified and dried by distillation and by crystallisation as the acetone-sodium iodide addition compound, was transferred by direct vacuum distillation. The measurements were carried out in two types of cryostat, one containing liquid paraffin and kerosene for temperatures above 0°, and the other containing ethyl bromide for the lower temperatures. The solubility of carbon dioxide in acetone was also determined over the range - 75° to + 20°, and the latent heats of evaporation at different temperatures were calculated from the vapour pressure data by means of the Clausius-Clapeyron equation.

LOW-TEMPERATURE CARBONISATION RETORT.—In pursuance of a policy of the Department of Scientific and Industrial Research adopted in 1924 (NATURE, September 20, 1924, p. 441), the Director of the Fuel Research Board has issued a report (H.M. Stationery Office, 9d. net) on a test on a 'Fusion' rotary retort for the carbonisation of fuels at low temperatures. The retort, installed at the works of Electro-Bleach and By-Products, Ltd., Cledford, consists of a horizontal externally heated rotary cylindrical retort, through which the material passes while stirred and kept from lodging on the walls by a special type of 'breaker.' The retort was rated to treat 5 tons per day, but in the test 3·4 tons of Welbeck Cannel was put through. 50 gallons of tar and oil was collected per ton, and it was shown that the recovery might have been increased to 54 gallons. 2740 cub. ft. of gas of calorific value 1070 B.T.U. per cub. ft. (gross) was obtained. No operating difficulties of any great consequence were noted. The test showed that a good yield of liquid products was obtained, but the solid product was in a finely divided form as a result of the action of the breaker and probably suitable for pulverised fuel firing. This may be satisfactory when dealing with a non-caking low-grade fuel, such as was used here. It restricts the scope of the process, which scarcely seems adapted to produce a smokeless domestic fuel.

THE SHOCK-WAVE FOLLOWING DETONATION OF HIGH EXPLOSIVES.—What is the nature of the 'shock-wave' sent out by the detonation of a high explosive? How far and at what speed does it travel? How is it that the flame from a high explosive may apparently penetrate a region occupied by an explosive gas mixture without igniting it? These are some of the problems raised by the use of high explosives in fiery mines, and they are problems which have not yet received authoritative answers. Indeed, it may be said that, until the recent work inaugurated by Prof. R. V. Wheeler, of the Safety in Mines Research Board, the functions of the shock-wave have not been so fully studied in England as they have been abroad, especially in France, where *l'onde du choc* has received both theoretical and practical investigation. The Mines Department has now issued a paper (No. 29) forming Part 2 of the research "On the Pressure-wave sent out by an Explosive," by W. Payman and W. C. F. Shepherd, assistants at the Mines Experimental Station. An apparatus has been constructed whereby the flame issuing from a high explosive has been directly photographed on a moving film, which at the same time registers the passage of the preceding shock-wave by *Schlieren* photography and also the movements of the products of combustion, since these were found to be opaque to the arc-light which gave the *Schlieren* effect with the pressure wave. It was thus possible to measure the speed of the shock-wave sent through the air by the explosion of a No. 6 Detonator, and its gradual slowing down as it travelled away from the experimental tube. The expanding products of combustion closely follow the shock-wave from the mouth of the tube, but soon begin to fall behind it. Behind the products of combustion the visible flame issues from the tube, and never gets in front of the products. This explains why a No. 6 Detonator will not ignite firedamp mixtures, since the inflammable gas would be shielded from the flame by an extinctive blanket of burnt products. The speed of the shock-wave as it starts through the open air was found to be roughly twice the velocity of sound.

Perth Meeting of the Australasian Association for the Advancement of Science.

THE eighteenth meeting of the Australasian Association for the Advancement of Science was held in Perth during the week commencing on Monday, August 23, but was extended in the form of excursions well into September. As this was the first time the Association had consented to visit Western Australia, special efforts were made to induce members from the other Australian States and New Zealand to attend the meeting. The State Government of Western Australia granted £1,200 for printing and publishing, and offered free transit over the State railways to all visiting members; and the Australian Commonwealth Government was induced for the first time to contribute towards the general expenses of the meeting the sum of £750, out of which travelling allowances were paid to members of known scientific standing who came to Perth over the Transcontinental Railway. Furthermore, private hospitality during the meeting was arranged in Perth for all members from other States who would accept it, and on most of the excursions members were carried free.

In response to the invitation more than 200 members from the other Australian States and New Zealand attended the meeting. To transport this number in addition to the ordinary traffic an average distance of more than two thousand miles each way taxed the resources of the Transcontinental Railway, but the task was satisfactorily accomplished. About half the visitors, including most of the principal officers of the Association, were carried in a special train, thus making the overland journey an excursion in itself. The total enrolment for the Perth meeting included about 750 members and more than 200 associates. Among the visiting members were delegates from some fifty scientific, technical, and educational bodies in the other States, and delegates from the Commonwealth Government and the Governments of New Zealand, New South Wales, and South Australia. More than twenty scientific and other bodies in Western Australia also sent delegates to the meeting.

At noon on Monday, August 23, the Mayor of Perth gave a civic reception to the Association in the Perth Town Hall. In the afternoon Mr. G. A. Julius, chairman of the reconstituted Council for Scientific and Industrial Research, addressed the Association on the organisation and aims of that body, and explained the important influence its activities must have on the future development of pure and applied science in Australia. In the evening the incoming president, Prof. Edward H. Rennie, delivered his inaugural address in the Perth Town Hall on "The Chemical Exploitation, Past, Present, and Future, of Australian Plants." The retiring president, Lieut.-General Sir John Monash, presided, and at the close of the address a cordial vote of thanks was proposed by the Governor of Western Australia (Sir William R. Campion) and seconded by the Mayor of Perth. On Thursday, August 26, the University of Western Australia gave a garden-party in its new grounds at Crawley. Three meetings of the General Council were held during the week, the most important business done being to adopt a new constitution for the Association and to advance the Subsection of Pharmacy to be a full Section to be designated "Section O." Sectional business extended from Tuesday, August 24, to Friday, August 27, inclusive, meetings being held in the daytime in the Perth Modern School and in the evening in the temporary buildings of the University. At the end of the week most of the visitors left to take part in various long-distance excursions.

An innovation tried in some of the sections at the Perth meeting was to hold evening sessions for papers and discussions on topics of more general interest, including in a few cases the sectional presidential address. This was to enable local business and professional men to take part who could not have attended in the daytime, thus extending the opportunities of the general public to share in the activities of the Association. The innovation was fully justified by results, and will probably be taken as a precedent at future meetings.

In his inaugural presidential address, Prof. Rennie, after an appreciative reference to the late J. H. Maiden, for many years general secretary of the Association, and Mr. F. G. Smith, well known for his work on the eucalyptus oils, gave a brief summary of recent work on the structure of the atom, the discovery of new elements, the possibility of atomic transformation, and the significance of the penetrating radiation discovered by Millikan. The main part of the address dealt, however, as its title implies, with the constituents and economic possibilities of Australian plant products, much of it describing Prof. Rennie's own work of the past forty years. The chief plant constituents and products considered were essential oils (eucalyptus, sandalwood, boronia, etc.), gums and resins, coloring matters, and the poisons which cause so much loss to stock owners and farmers. Prof. Rennie strongly urged the need in all the Australian States for active reafforestation to maintain a supply of raw materials, and for research on new products and on methods of utilising the present great waste from timber mills.

At the conclusion of his address, the president presented the Mueller medal of the Association to Prof. F. Wood Jones, for distinguished work in anthropology.

In Section A (Astronomy, Mathematics, and Physics) Prof. Kerr Grant gave the presidential address on "Atomic Transmutation." He showed that the developments in physics during the past twenty-five years are based chiefly on the theory of relativity, the quantum theory and the theory of the nucleus atom. The various attempts that have been made to bring about transmutation were reviewed and discussed, and the conclusion was drawn that transmutation of the heavier elements by artificial means, although not improbable, has not adequately been proved.

In his presidential address to Section B (Chemistry) on "Some Aspects of the Problem of Molecular Structure," Prof. James Kenner reviewed the chemical and physical data at present available for developing a rational theory of molecular structure. Such a theory must account for the intricate structure of carbon compounds as well as for absorption, catalysis, and molecular association, the last being specially important since substances like the proteins and rubber have been shown to be associations of relatively simple molecules. Prof. Kenner believes that a firm basis for such a theory and the means to develop it are already at hand. This address followed that in Section A, the two addresses in fact being the first items in a joint discussion of the two Sections on "The Atom and Valency."

In Subsection B (Pharmacy) Mr. A. T. S. Sissons gave the presidential address on "The Indebtedness of Pharmacy to Organic Chemistry," summarising the achievements of organic chemistry in purifying and standardising naturally occurring drugs, and in synthesising these together with many others not found in Nature.

In Section C (Geology and Mineralogy) Sir Douglas Mawson, president of the Section, gave an address on "The Igneous Rocks of South Australia—a Brief Survey of Present Knowledge Relating Thereto." Igneous activity in South Australia appears to have been restricted to four periods: the older pre-Cambrian, as seen at Port Lincoln and Carrow; middle pre-Cambrian, shown by uncrushed granites in the Eyre Peninsula; late pre-Cambrian, as in parts of the Mt. Lofty Ranges; and Tertiary, as in the effusions in the Mt. Gambier district and on Kangaroo Island.

Prof. Launcelot Harrison, president of Section D (Zoology) gave an address on "The Composition and Origins of the Australian Fauna, with special reference to the Wegener Hypothesis" The Australian fauna seems to have had three main origins: an Autochthonian, established in the south-west in very early times; a Euriotian, probably derived by way of the Antarctic continent in Mesozoic or Miocene times; and a more recent Papuan element. The address served also to open a joint discussion between Sections A, C, D, E, and M on "Biological, Geological, and Physical Evidences regarding the Relationship of Australia to other Lands, with special reference to the Continental Drift Theory."

In Section E (Geography and History), Prof. Ernest Scott took as the title of his presidential address "The Discoveries of the Western Australian Coast, with especial reference to Dampier and D'Entrecasteaux," in which he gave the results of an examination of documents bearing on the history of the ill-fated D'Entrecasteaux Expedition in the Archives Nationales in Paris.

The presidential address in Section F (Ethnology and Anthropology), by Prof. F. Wood Jones, contained caustic comment on the treatment meted out to the Australian aborigines in the past, and urged that the only way in which the race can be saved from extinction is by establishing native reserves, where the natives can live their own lives under natural conditions and be protected from pauperisation.

In Section G (Social and Statistical Science) the president, Major L. F. Giblin, took as the title of his address "Federation and Finance—an Examination of the Financial Relations of States to a Federal Commonwealth." In this he showed that the present financial arrangements between the Commonwealth and the States, including taxation, are almost exclusively on a *per capita* basis, which is inequitable, as wealth and population do not run parallel.

Sir Charles Rosenthal, president of Section H (Engineering and Architecture), was unable to attend, but forwarded his address on "Nation Building," which was read to the Section. The address dealt with the dependence of the progress of civilisation on engineering and architecture, and amongst other things urged the necessity on strategic and economic grounds for a uniform gauge for the Australian railways.

In Section I (Sanitary Science and Hygiene) the president, Dr. F. S. Hone, gave an address on "Notification and its Relation to the Prevention of Disease," in which he showed the great need for co-ordination and reform of the methods of notification in use in the Australian States. To make notification effective for controlling disease, the number of permanent medical officers of health will have to be increased.

In Section J (Mental Science and Education) Mr. P. Board spoke on "Economic and Social Values in Education." Education creates the soul of the nation, acting as the sum of the effects of all the teachers on all the pupils. An extension of the school age is desirable, but will probably require some form of family endowment.

Mr. C E. Lane Poole, president of Section K (Agriculture and Forestry), who was unable to attend, forwarded an address on "Forestry and Land Settlement." Forestry is agriculture on a long rotation, and to convert good forests into poor grazing land, as so often happens in Australia, is economically unsound; also the wholesale destruction of forests affects the climate adversely.

Prof. J. Douglas Stewart addressed Section L Veterinary Science) on "The Relationship of Veterinary Science to the Prosperity of the State." Heavy losses of stock are caused annually by parasitic and other diseases These can be combated successfully only by preventing infestation, but this requires a knowledge of the life history of the parasites, which in many cases we do not possess Much research is needed, but the veterinary services of the Commonwealth are sadly undermanned.

In Section M (Botany) Prof A J. Ewart gave his address on "Past, Present, and Future Development of Botanical Science," dealing with the killing of weeds by poison, which at present is done on purely haphazard and empirical lines, the need for botanical research in Western Australia, and modern views on the ascent of sap in trees.

In the new Section N (Physiology and Experimental Biology) Prof W. A. Osborne gave the presidential address on "The Study of the Reflex." The response to changes in environment is one of the most obvious manifestations of life, and the higher the organism the wider the range of environmental changes to which it is sensitive. In man the highest form of reflex action is found in the emotions. Prof. Osborne suggested that many body changes that seem without purpose in the individual become clear when the individual is regarded as a member of a society, as they express the interaction between him and his fellows.

Most of the sections had very full programmes. Intersectional discussions were a prominent feature of the meeting, the following discussions being held in addition to those already mentioned: "Catalysis and Enzyme Action" and "Hydrogen-ion Concentration" (Sections B and N), "Teaching of Hygiene in Schools" (I and J), "Soil Classification and Survey" (B, C, K, and M), "Adult Education and the Workers' Educational Association" (E, G, and J), "Poison Plants" (B, K, L, and M), "Water Supplies—Domestic, Agricultural, and Pastoral" (B, C, H, I, K, L, and N), "Treatment of Low-grade Ores" (B and H), "Biological Control of Pests" (D, K, L, and M), and "Timber Preservation" (B, H, K, and M).

Danish Observations of the Planet Jupiter.[1]

THE observations of the planet Jupiter made at the Urania Observatory, Copenhagen, during the period 1919–24 are summarised in the publication before us. By far the greater part of the report, however, deals with the observations secured during the very remarkable apparition of 1919–20—an apparition which saw the revival of the well-known hollow in which the Red Spot normally lies, the south tropical disturbance, and the south component of the south equatorial belt—all of which had disappeared in the earlier part of 1919. In the succeeding apparitions, bad meteorological conditions, and later the low position of the planet in the sky, rendered systematic work impossible. We accordingly limit our reference to the discussion of the 1919–20 observations.

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[1] La surface de la planète Jupiter 1919–1924 Par C. Luplau Janssen. (D. Kgl Danske Vidensk. Selsk Skrifter, naturvidensk. og mathem. Afd, 8 Række, XI, 1) Pp. 88+[illegible] plates. (København: Andr. Fred. Høst and Son, 1926.) 10 kr.

The work done may be divided into three parts:

(1) Micrometrical measures for determining the co-ordinates of individual spots.

(2) Micrometrical measures for determining the latitudes of the belts.

(3) Descriptive notes and drawings of the surface features.

M. Luplau Janssen is a firm believer in determining the longitudes as well as the latitudes of Jovian markings with the micrometer, but some eye-estimated transits across the central meridian were also recorded. Many of the older observers of the planet will recollect the discussions which took place several years ago as to the relative merits of the two methods of deriving longitudes. A comparison of M. Luplau Janssen's micrometric results with central meridian transits by other observers shows the accuracy attained to be of much the same order, but it seems to the reviewer that in a given time a considerably larger number of spots can be observed by the transit method, which is a matter of great importance. On the other hand, valuable results can, of course, often be obtained with the micrometer of an object which has already been observed by the transit method, or for some other reason cannot be observed at its central passage. Micrometer measures also have the advantage of furnishing values for the equatorial as well as the polar diameter of the planet, and from his series of observations in 1919–20, M. Luplau Janssen deduces the figures 37″·72 and 35″·54 respectively at mean distance, which gives for the oblateness of the disc the value $\frac{1}{17}$. The figures for the equatorial and polar diameters at present adopted in the physical ephemerides are 37″·87 and 35″·35.

In the discussion of the observations of individual spots, the conclusions drawn suffer from the, relatively speaking, small number of longitude determinations. In fact, the identifications in some cases seem to the reviewer to be entirely erroneous. A striking example is found in the case of some remarkable spots observed in the south tropical zone (the zone between M. Luplau Janssen's bands IV. and V.). On p. 66 of his report five observations are taken together as referring to one and the same object, but if we accept the conclusions arrived at in the twenty-second report of the Jupiter Section of the British Astronomical Association recently published, which are based on a very much larger number of observations, we find that they actually belong to four separate objects, and that what is, perhaps, the most interesting fact revealed during the apparition—namely, the abnormal drift in opposite directions of two pairs of spots—has been entirely missed. Similarly, when all the available material is considered it appears that mistakes in the adopted identifications are accountable for some of the large irregularities of motion attributed to certain other spots by M. Luplau Janssen.

A valuable part of the report is that which contains a summary of the micrometrical measures of the latitudes of the belts and a comparison with results obtained by other observers in previous years. As has been often remarked, the latitudes of the belts show considerable variations, and especially has this been the case in recent years with the north edge of the north equatorial belt (M. Luplau Janssen's band III.). M. Luplau Janssen considers that there is evidence in the measures of some of the belts of changes of a periodic nature which are related to the position of the planet in its orbit. It may be questioned whether the available evidence is sufficiently strong to warrant such a conclusion, but the matter is certainly worth careful investigation, and there can be no doubt that measures of the positions of the belts (as emphasised several years ago by the late Prof. G. W. Hough) should be regarded as an important part of the work on Jupiter. M. Luplau Janssen lays emphasis on the stability in position of the south equatorial belt (his band IV.); yet it is worth noting that it is this belt which in 1919 and again in the present year has faded to such an extent as to become invisible save for its north component. Overlying vapours may perhaps be accountable for the effect observed, but on the other hand, in 1920 the revival was attended by disturbances which seemed to indicate some deep-seated cause in the planet's interior.

At the end of the report are seven plates containing 41 drawings, 37 of which belong to the apparition of 1919–20. These drawings illustrate the remarkably rapid and amazingly complicated changes which were associated with the great revival of the south equatorial belt and the south tropical disturbance during that apparition.

Taken as a whole, the report contains a mass of valuable data which will be very welcome to all students of the planet.

The Problem of Secretion.

THE attention of those who are interested in the problem of secretion is directed to a series of three papers by Dr. Robert H. Bowen, of Columbia University, New York, which have appeared in the current volume of the *Quarterly Journal of Microscopical Science* (vol. 70, parts 1, 2, and 3), and especially to the very capable critique of the topography, structure, and function of the Golgi apparatus in glandular tissue which he has given in a fourth paper (part 3, October 1926). Believing that the older theories of secretion had broken down and that the field was clear for the thorough examination of the Golgi apparatus as a synthetic intermediary in the process of secretion, he has concentrated his attention on this subject and has made only brief references to the secretory possibilities of other components of the cell.

Dr. Bowen concludes that the Golgi apparatus is present from the beginning in all kinds of secretory cells, and, when large numbers of secretory granules are being produced, becomes greatly hypertrophied, establishing a volume in rough relation to that of the secretory products, the other elements of the cell diminishing more and more. The topography and behaviour of the Golgi apparatus are different in different kinds of glands, but can be divided roughly into three general types characteristic of cells which produce serous, mucous, and lipoidal secretions. The secretory granules make their first appearance only within the area delimited by the Golgi apparatus. In a few cases there are indications that the secretory granules arise in close connexion with the Golgi material, and in fact that there is a constant and intimate topographical association between them. Dr. Bowen concludes that the secretory granules are differentiated by the Golgi material, but that no direct transformation of one into the other occurs, such as has been claimed by some authors who have advocated the mitochondrial origin of secretions. Dr. Bowen suggests that the Golgi material is structurally homologous throughout the range of animal cells, and that the so-called idiosomic substance sometimes associated with it is to be looked upon as one phase of a duplex system in which the relative development of lipoidal and idiosomic substances may undergo considerable variation.

Having established a probability in favour of the essential homology between secretory granules and the acrosome of the animal sperm, Dr. Bowen suggests that the relationship between the Golgi apparatus and the secretory granules is homologous to that existing between the Golgi apparatus and the acrosome, and that our more complete understanding of the latter phenomenon can be used as a basis for interpreting the much more obscure phenomena in the gland cell. He adds that the establishment of the views developed in his paper must depend finally upon further critical evidence from favourable material bearing upon the exact relation which exists between the individual secretory granule and the Golgi complex.

Dr. Bowen holds that no cytological evidence of the origin of secretory products from the nucleus receives any acceptance at the present time. The nucleus can be considered as the source of secretions only in the indirect sense that it may possibly exercise some control over the process as a whole, or may collaborate with other parts of the cell-system in preparing materials for the synthetic operations of the Golgi apparatus.

When a cell is divided into a nucleated and a non-nucleated portion, the latter is able to carry on synthetic activities for a brief period only; meanwhile the nucleated part regenerates and appears none the worse for the operation. Hence it was concluded that the nucleus is the centre of synthetic operations, and particularly of the formation of those intracellular enzymes upon which living activity is now supposed to depend. But it is at least equally possible that the nucleated piece alone continues capable of constructive metabolism because it possesses the complete cell-system, while in the non-nucleated piece the system is disrupted. Dr. Bowen remarks that if the Golgi apparatus could be eliminated, the cell would doubtless be fatally affected. While secretion is an activity in which the cell-system as a whole is probably involved, and over which the nucleus exercises some controlling influence, the actual synthetic centre for the differentiation of secretory granules is the Golgi apparatus. That this source of the visible secretory granules "is likewise the source of the invisible, intra-cellular enzymes . . . cannot at present be doubted, but our scanty knowledge of these things makes any hypothesis whatever almost pure speculation."

Forestry in Illinois and Great Britain.

It is common knowledge that the drain upon the world's resources of coniferous timber is very heavy, and that in some countries the outlook is regarded with increasing disquietude. In the "Third Report on a Forest Survey of Illinois," by C. J. Telford, the position of the State is explained with great clarity, and the parallel to the state of affairs existing in Great Britain is depicted. The present forests of the United States contain an estimated total of 481,800 million cubic feet of standing timber, the annual cut is 25,000 million cubic feet and the annual growth 6039 million cubic feet. "The virgin forests," the report says, "will carry us another 25 years, after which we shall probably be wholly dependent upon growth from cut-over lands. By utilising the entire 470 million acres of forest lands at prevailing rates of growth these cut-over lands can supply us with an estimated annual yield of 14,000 million cubic feet—a little more than half our present requirements. The conviction that satisfactory substitutes for wood will be found is untenable when the enormous amount of wood required is appreciated. This drain of 25,000 million cubic feet of standing timber a year means that for every hundred pounds of coal, iron, cement, petroleum and copper consumed the forests supply 67 pounds of wood, and the crop lands supply 44 pounds of all forms of crops, including cereals, seeds, clover, hay, forage, cotton, potatoes, sugar, fruit, and nuts. It is obvious that a satisfactory substitution for a commodity representing by weight two-thirds of virtually all the minerals consumed, or one and a half times all crops raised in the United States, is impossible. A timber famine will be more disastrous to Illinois than to any other State. Its manufacturing establishments employ 11·6 per cent. more hands than agriculture, transportation, and mining combined, and thirty per cent. of all persons employed in manufacture are in industries dependent upon wood. In the single item of lumber, Illinois consumes one-thirtieth the total lumber-cut of the world."

The process of forest destruction is far advanced in Illinois. Virgin timber has practically disappeared, and the present drain on the cut-over forests and second growth stands, unchecked, will, it is held, result in an early disappearance of all forests in the State. There was an increase in unforested waste land of 250,000 acres in the ten years from 1910 to 1920, and Illinois now has a total of 1,577,663 acres in this class. The 3,021,650 acres now forested are on lands unsuited to ordinary farming, and if cleared will generally revert to waste land. The state of affairs thus briefly delineated is sufficiently alarming from the industrial outlook alone and renders the more interesting the following comparison with the position of Great Britain.

"There is a striking parallel between Illinois and Great Britain in the total wood consumption and in the total area forested. Each annually consumes approximately the same quantity of wood—560,720,000 cubic feet for Illinois and 600,000,000 cubic feet for Great Britain; each has about the same area forested—3,021,650 for Illinois and about 3,000,000 acres for Great Britain. But Great Britain, despite a population of 437·5 to the square mile as compared with 115·7 in Illinois, and the consequent pressure for land, has deliberately undertaken to replant 1,770,000 acres, and this planting is being done at the rate of 20,000 acres a year. Illinois has never planted 200 acres of publicly owned forests, her farm woodlands are decreasing at the rate of 4500 acres a year, and the unimproved and waste land on farms is increasing at the rate of 25,000 acres a year."

Bird Flight.

In the *Transactions of the Royal Society of South Australia*, vol. i., 1926, an interesting contribution is made by Prof. F. Wood Jones on the flight of sea-birds. It has long been observed that many sea-birds spend protracted periods, sometimes soaring, sometimes gliding, and at any rate to the novice, apparently without a visible tremor of the wing. Their flight appears to be merely an ability to slide ahead with no other power than their own weight and a presumably instantaneous ability to readjust their planes and alter their cant and poise apparently largely by movements of the head.

As a result of close study and observation extending over many years, Hankin maintains that in the wake of a ship the air must possess a physical property which he terms 'soarability' by means of which sea-birds are enabled to extract from the air in that region an upward momentum. Presumably this must mean that the air in passing over the ship is set into a state of disturbed eddying of such a general direction of rotation and of such a distribution of intensity vertically that the bird experiences a lift it would not otherwise acquire.

Prof. Wood Jones, on the other hand, regards the soaring and gliding of pelagic birds as due rather to a morphological adaptation of the bird as an adjusted plane than to any chance condition of "soarable" air. Regarded in this way, he maintains, the zoned north and south distribution of the different morphological types of sea-birds and the failure of the albatross, for example, to follow ships into the tropics, well adapted as it is for gliding, must be investigated from the point of view of bird structure correlated to the environment to which it appears to be adapted. In the case of the albatross, there appears to be a perfect mastery of aerial conditions well to the south of the equator, a lessening mastery farther north, and a positive disability, laboured flapping flight, as the journey is made towards the equator. The same facts apparently hold with regard to the northern representatives.

Prof. Wood Jones points out, moreover, that the zonal distribution of species from the equator northwards is very similar to the distribution southwards from the equator, with a similar increasing ratio of weight to wing area, culminating at both poles with the southern penguins at one end and their extraordinary parallels, the northern auks, at the other. The clue to this gradation is to be sought in the increase in atmospheric density from the equator in both directions, so that a bird adapted for flight in the denser atmosphere finds difficulty in maintaining its gliding and soaring in the rarer atmospheres of the tropics. By indicating this new line of approach, Prof. Wood Jones undoubtedly has given a new impetus to the study of bird flight.

University and Educational Intelligence.

Birmingham.—Mr. H. Munro Fox, fellow of Gonville and Caius College, Cambridge, has been appointed to the Mason chair of zoology to succeed the late Prof. F. W. Gamble. Mr. C. G. C. Chesters has been appointed assistant lecturer in botany.

The Council has recommended to the Court of Governors that the title of emeritus professor be conferred on Thomas Turner, formerly professor of metallurgy.

Edinburgh.—At the graduation ceremony on December 17, the degree of D.Sc. was conferred on Baini Prashad, Superintendent of the Zoological Survey of India, the Indian Museum, Calcutta, for his thesis on (1) "Recent and Fossil Viviparidæ: a Study in Distribution, Evolution, and Palæogeography," and (2) "The Shell and Mantle of the Viviparidæ"; the degree of Ph.D. on R. K. S. Mitchell for his thesis on "Some β Octyl Esters of Substituted Acetic Acid"; and the degree of M.D. on Eric H. Ponder, with gold medal, for his thesis on "Studies in Hæmatology."

Applications are invited by Yale University for two Theresa Seessel Research Fellowships for the promotion of original research in biological studies. The value of each is 1500 dollars. Preference will be given to candidates who have already obtained their doctorate, and have demonstrated by their work fitness to carry on successfully original research of a high order. The holder must reside in New Haven during the college year, October to June. Applications, accompanied by reprints of scientific publications, letters of recommendation, and a statement of the particular problem which the candidate expects to investigate, should be made to the Dean of the Graduate School, New Haven, Conn., before March 1, 1927.

In the course of the past year inquiries were made by the Institution of Mechanical Engineers of the colleges and schools conducting approved part-time courses as to the ages and occupations of candidates for the Ordinary and Higher National Certificates in mechanical engineering. Information has been supplied from 85 colleges and schools in Great Britain in respect of 1000 candidates for the ordinary certificate and 334 for the higher certificate. The average age of the former candidates was about 19·5 years, and of the latter about 21·5 years. No less than 801 of the 1000 candidates for the ordinary certificate were between the ages of 18 and 21 years. Classifying the candidates in respect of occupation, it was found that apprentices of all classes constitute 71·3 per cent. of the candidates for the ordinary certificate, and 32·4 per cent. of those for the higher certificate, and that the combined proportions of trade apprentices and mechanics following these courses are 42·4 per cent. for the ordinary certificate and 37·7 per cent. for the higher certificate. The proportions of successful candidates were 52·5 per cent. for the ordinary certificate and 67 per cent. for the higher certificate.

The East Anglian Institute of Agriculture, Chelmsford, announces in its Calendar for 1926–27 that alterations during 1925–26 have enabled it to offer facilities for instruction of a more advanced character than that obtainable at any similar institute in Great Britain. The research work at present in progress includes deterioration diseases of potatoes, seeds mixtures, autumn versus spring sowings, composition of butter-fat in goat's milk, winter spraying, colonisation of salt marshes, bunt in wheat, wheat bulb fly, and Hessian fly. Agricultural economics courses include one on the history of British agriculture. Special courses on the agriculture of New Zealand, of Australia, and of Canada and South Africa, are provided. A list of appointments held by past students does not indicate that any of them have as yet gone abroad. The North of Scotland College of Agriculture has a very different record in this respect, a very large proportion of the posts held by its former students being in other countries. The Calendar of this College for 1926–27 announces, among other courses, a "Planter's Certificate Course" specially provided to meet the requirements of students intending to enter on service upon tea, coffee, rubber, sugar, and other plantations in tropical and subtropical countries. It extends over two complete winter sessions and one intervening summer session. No preliminary qualifying examination is prescribed. Nine students obtained the degree of B.Sc. in agriculture during the past session. The courses in forestry formerly provided by the College have been transferred to the University of Aberdeen. The Edinburgh and East of Scotland College of Agriculture has in the past, like the North of Scotland College, sent many students abroad, but the list published in its new Calendar of appointments gained by students shows a falling off in this respect. This College, like the East Anglian Institute, offers a course on the history of British agriculture based on Lord Ernle's "English Farming, Past and Present."

Calendar of Discovery and Invention.

January 1, 1801.—After the enunciation of Bode's law and the discovery of Uranus, it was thought there must be an undiscovered planet the path of which lay between the orbits of Mars and Jupiter. A group of astronomers, therefore, agreed to make a systematic search, and on January 1, 1801, Giuseppe Piazzi, at Palermo, saw Ceres, the first of the minor planets or asteroids. By 1845 four others had been discovered, but since the application of photography to astronomy many hundreds have been identified. Ceres, however, is the largest, being 485 miles in diameter.

January 1, 1855.—Among the methods used for determining the density of the earth is that introduced by Airy, who, in 1826 and 1828, with Whewell and Sheepshanks, made pendulum experiments at Dolcoath Mine, Cornwall. Later, he repeated these experiments at Harton Colliery, South Shields, at a depth of 1260 feet, and gave an account of these in a lecture at South Shields on January 1, 1855. The result he obtained gave 6·56 as the mean density—a value, however, considerably too high.

January 2, 1818.—The foundation of the Institution of Civil Engineers was due to six engineers, of whom the best known were William Maudslay, Joshua Field, and Henry Robinson Palmer. The first formal meeting was held at the Kendal Coffee House, Fleet Street, on January 2, 1818. On January 23, 1820, it was proposed to ask Thomas Telford to become president. He was formally installed on March 21 of that year, and held the presidency until his death in 1834. The first home of the Institution was at 15 Buckingham Street, Adelphi, and the first volume of *Proceedings* was issued in 1836.

January 3, 1752.—While spectrum analysis was due to Newton, it was the young divinity student Thomas Melvill who first used a prism for the examination of various flames; introducing sal-ammoniac, potash, alum, etc., into burning spirits. He gave an account of his experiments to the Medical Society of Edinburgh on January 3, 1752, while another paper of his was read to the Royal Society in 1753 by Bradley. (See NATURE, November 5, 1914, vol. 94, p. 263.)

January 4, 1896.—On this day Röntgen gave an account of his discovery of X-rays to the Physical Society of Berlin. His discovery was made on November 8, 1895, and was described in a paper entitled "On a New Kind of Rays," which appeared in the *Sitzungsberichte der Würzburger physik.-medic. Gesellschaft.* A translation of this paper was given in NATURE of January 23, 1896, together with an article and an X-ray photograph contributed by Mr. A. A. Campbell Swinton.

January 7, 1610.—No accidental discovery has had more far-reaching results than the discovery of the principle of the telescope. From the report of what Lippershey had done, Galileo made telescopes magnifying three, eight, and thirty times, and on January 7, 1610, at one o'clock in the morning, observed for the first time three of the satellites of Jupiter, and thus ushered in the era which has seen so vast an extension of our knowledge of the sky.

January 7, 1785.—The first to make a balloon ascent solely for scientific purposes, Dr. John Jeffries, on January 7, 1785, with the famous aeronaut Blanchard, crossed the English Channel from Dover to Calais, where a marble column was erected to commemorate the feat. On an ascent from London in 1784, Jeffries carried with him meteorological instruments and obtained samples of air at various heights for Cavendish.

E. C. S.

Societies and Academies.

LONDON.

British Mycological Society, November 20.—**W. J. Dowson**: An unusual species of Botrytis attacking Narcissus. The fungus is the cause of 'fire,' marking the leaves with one or more yellow patches. The spores of the fungus are very large, and germinate with as many as thirteen germ tubes after up to one hour in water or in dilute glycerine.—**Miss A. Lorrain Smith**: A new family of lichens. The lichen *Cryptothecia subnidulans* was described by the late Dr. Stirton, and has led to much difficulty in assigning it to a systematic position. Stirton's herbarium has revealed three additional species of the genus and two closely allied ones for which a new genus is proposed; the two genera form a family characterised by the apparently double-walled ascus containing septate or muriform spores and embedded in a lax peridium of interwoven hyphæ. Affinity with the fungi Myriangiales and Gymnoascales is suggested; the nearest lichen allies appear to be Thelocarpaceæ and Mycoporaceæ.—**O. V. Darbishire**: Isidia and soralia of lichens. Isidia in *Peltigera praetextata* develop endogenously from special hyphæ which make their way to the surface, breaking through the cortex or making use of a crack. The mature isidia are very highly developed assimilators. There is a primary cortex on the upper surface with walls of wavy outline. The secondary cortex is similar to the cortex of the thallus. The gonidia are fairly closely packed towards the upper cortex with a very loose arrangement just inside the lower cortex. This cortex is of one layer of cells, with sinuate walls and interrupted here and there by pores. Soredia also have an endogenous origin. A few gonidia are gradually surrounded by the fungus and the differentiating soredium is raised to the surface of the sorial tissue, from which it becomes detached as a reproductive organ.—**W. R. I. Cook**: The genus Ligniera. Cross inoculations have shown that several species which have been described are merely host varieties. Infection takes place by zoospores entering root hairs. Spores serve as a resting stage and for propagation within the plant. Reduction division occurs at the formation both of spores and zoospores. Conjugation has not been seen.—**W. A. Roach**: On the nature of disease resistance in plants, with special reference to the wart disease of potatoes. Wart disease is an example of physiological resistance. Evidence at present suggests that immune and susceptible varieties form two distinct classes and not end members of a continuous series. The reaction towards wart disease is unaffected by grafting on either a foliage system, a root system, or of a complete plant of opposite reaction to the disease. Immunity from, or susceptibility to, wart disease is therefore probably innate to the cell and must be sought in compounds which cannot cross a graft fusion layer unchanged, and so probably cannot leave a cell. These compounds may be proteins.

Geological Society, December 1.—**Howel Williams**: The geology of the Snowdon massif (North Wales). The area described is limited on the north-east by the Pass of Llanberis, on the south-east by the Vale of Gwynant, on the south-west by the Colwyn and Gwyrfai Valleys to near the village of Salem, and on the north-west by the supposed line of junction between the Cambrian and the Ordovician rocks. The general stratigraphical succession is made out. The exact relationship between the Ordovician and the Cambrian systems on the northern flank of Snowdon is uncertain. Ramsay's threefold division of the

Snowdon Volcanic Suite remains the most useful basis for its study. The Upper and Lower Rhyolitic series were derived from a potash-rich magma. The approximate age of the Snowdon Volcanic suite is inferred to be between Middle Llandeilian (zone of *Climacograptus peltifer*) and Middle Caradocian (zone of *Dicranograptus clingani*). Many dykes, inclined sheets, and bosses of quartz-porphyry, microgranophyre, and intrusive rhyolite occur on Snowdon, the largest intrusion being that of Crib Goch, formerly considered to be an outlier of the Upper Rhyolitic Series. Both mineralogically and chemically, the acid intrusive rocks resemble the Snowdon rhyolites. Pre-cleavage sills of augite-dolerite and spilitic dolerite occur at several horizons, and present various biotite- and copper-rich modifications. The major folding is of north-east-and-south-west strike, and occurred almost wholly after the period of basic intrusions. Its dominant expression is the so-called 'Snowdon syncline,' the north-western limb of which lies in a recumbent position in the area immediately south of Rhyd-ddu. The major folding was succeeded first by a cleavage of similar strike, and afterwards by a minor folding and thrusting due to pressures directed south-eastwards, the thrusting being most pronounced along the recumbent limb of the 'Snowdon syncline.' Finally, the area was broken into blocks by faults, most of which belong to the same family of movements as those just enumerated, although some may have moved again during the Tertiary era.—**Albert Heard**: On Lower Old Red Sandstone plants showing structure, from Brecon (South Wales). A new fossil plant locality is recorded from the Senni beds in the neighbourhood of Brecon. A new Lower Old Red Sandstone plant, *Gosslingia breconensis*, is recorded; the plant is rootless and leafless, with stomata and hairs; gregarious, erect, dichotomously-branched, cylindrical stems arise from dichotomously-branched rhizomes with rhizoids; the stems are circinately coiled in the apical regions. The stele consists of a large strand of tracheids which have both spiral and reticulate thickening, surrounded by protoxylem and phloem; the outer cortex of the aerial stem consists of four layers of thick-walled cells. Reniform appendages borne on special branches are interpreted as sporangia. There is also a peculiar organism resembling Pachytheca.

Society of Public Analysts, December 1.—**William G. Savage**: Recent advances in the bacteriological examination of food and water. The four tests used to differentiate the high and low types of coliform organisms in water and their value as indicators of excremental contamination are discussed. As regards milk, the value of examining centrifugalised deposits for the tubercle bacillus is considered, and new tests for distinguishing pathogenic streptococci from those of bovine origin not injurious to man are described.—**L. H. Lampitt, E. B. Hughes**, and **L. H. Trace**: On the presence and detection of furfural in vinegar. In the distillation of malt vinegar or wine vinegar, furfural is produced by the acid hydrolysis of the pentosans contained in the vinegar. Added caramel in vinegar will only give the furfural it originally contained as such. A modified aniline acetate test has been devised wherein the rose-coloured furfuraniline is extracted by an immiscible solvent, amyl alcohol. Thus dark-coloured vinegar may be tested for furfural without distillation. The test is quantitative.—**E. R. Dovey**: The rapid determination of opium in stomach contents. A standard solution is made from ordinary prepared opium which has itself been standardised to contain 10 per cent. of morphine and 5 per cent. of meconic acid. A measured quantity of the stomach washings are treated successively with dilute hydrochloric acid, mercuric chloride solution, and ferric chloride solution, and the resulting colour is matched with that given by the standard under the same conditions. The mercuric chloride inhibits the formation of any coloration with thiocyanic acid in the opium.—**C. H. Manley**: A rapid method for the sorting of butters and margarines. The method depends upon the butyric acid content of butter fat. The filtered fat is saponified, the soap solution acidified with sulphuric acid, and the insoluble fatty acids filtered off under specified conditions. The excess of sulphuric acid in the filtrate is neutralised (methyl orange as indicator) and the titration with standard alkali continued to neutrality, with phenol phthalein as indicator. The difference between the result and that obtained in a blank test affords a measure of the soluble fatty acids. The neutral solution may be used for determining the Kirschner value.

CAMBRIDGE.

Philosophical Society, November 22.—**H. W. B. Skinner**: On the polarisation of mercury lines emitted from a discharge tube in a magnetic field.—**C. F. Sharman**: The application of the method of the magnetic spectrum to the study of secondary electronic emission. The relative merits of the method of retarding potentials and of the magnetic spectrum for the investigation of the energy distribution of electronic emissions are discussed. The latter method was used in the case of the secondary emission excited in metal surfaces by a beam of electrons with energies between 100 v. and 1000 v. With a copper target, the distribution curve is very nearly independent of the energy of the primary beam. The results are in general agreement with those obtained by means of retarding potentials; there is, however, a discrepancy in the position of the low energy peak as given by the two methods.—**L. H. Thomas**: The calculation of atomic fields. The effective field V inside an atom is assumed to be that due to the nuclear charge and to electrons distributed uniformly in the phase space of their motion in the field at 2 for each h^3 of phase space corresponding to closed orbits. Thus

$$\nabla^2 V = \frac{64\sqrt{2}}{3}\pi^2 \frac{e^{\frac{5}{2}}m^{\frac{3}{2}}}{h^3}V^{\frac{3}{2}}.$$

The fields so calculated agree well with those that have been constructed to fit X-ray data.—**L. Wertenstein**: A contribution to the theory of diffusion pumps. The mercury vapour stream in a diffusion pump carrying gas from the 'low pressure' side to the 'high pressure' side creates a pressure gradient which explains the working of the pump. The pressure gradient is given by a diffusion formula (Gaede, Hertz) or directly by a dynamical method (corresponding to the calculation of diffusion coefficients by dynamical considerations: Langevin, Chapman). The agreement is excellent for hydrogen, a little worse for air. Hence the final ratio of pressures on 'high' and 'low' pressures side of a diffusion pump must be higher when the diffusion coefficient is smaller, *i.e.*, that so far as final vacuum is concerned, the diffusion pump is more efficient for heavier than for lighter gases. This result seems at first in contradiction with the fact that the diffusion pump pumps out quicker the lighter gases, but it was found that, at the same temperature, carbon dioxide was removed more perfectly than argon, and argon than hydrogen.—**W. Burnside**: On a group of order 25920 and the projective transformations of a cubic surface.—**P. A. M. Dirac**: The Compton effect in wave mechanics.—**J. B. S. Haldane**: A mathematical theory of natural and artificial selection. Part iv.—G. C. **Steward**: On the addition of the primary aberrations. In applying the characteristic function to particular optical systems three steps are necessary: the properties of the composite system must be examined in general, and then their dependence upon the corresponding properties of the component systems, and finally an examination must be made of the simplest components. The first and third of these have been undertaken elsewhere; a simple method is now given of achieving the second step—the method being applicable especially to the primary aberrations. Relations are obtained between the aberration coefficients of the composite system and the corresponding coefficients of the components.

LEEDS.

Philosophical and Literary Society, November 2.—P. K. **Dutt**: Anilopyrine and antipyrine (Preliminary Note). Anilopyrine alkohydroxides, in the absence of water, decompose spontaneously into 2-alkyl 5-pyrazolones, and a secondary amine. Further, the character of the substituents in position 2 and in the 5-amino group profoundly influences the yields of the two products. The fallacy of Michaelis's arguments in support of his bridge formula for anilopyrine is pointed out; there is no ground for discarding the anil structure of anilopyrine suggested by Stolz.—H. M. **Dawson** and C. R. **Hoskins**: Isohydric solutions and the velocity of chemical change. Measurements of the rate of reaction of acetone with iodine under the catalysing influence of isohydric solutions containing equivalent quantities of acetic acid and sodium acetate are in accord with the view that the reaction velocity corresponds with the sum of effects due respectively to the hydrogen ion, the hydroxyl ion, the acetate ion, and the undissociated acid. The proportion of the total effect attributable to the hydrogen and hydroxyl ions amounts to about 30 per cent. in a 0·005 molar solution, whereas this proportion is only about 0·2 per cent. in the case of a molar solution.—H. M. **Dawson** and L. H. **Angus**: The nature of solutions of the strong acids from the standpoint of the salt effect: the system nitric acid, sodium nitrate. The changes produced in the solubility of iodine in water by the addition of sodium nitrate can be expressed by an exponential formula $S = S_0e^{-kc}$. When nitric acid solutions (1·3 N and 2·7 N) are substituted for water, there is no change in the nature of the salt effect. The observations support the view that nitric acid is an almost completely ionised electrolyte.—R. **Whytlaw Gray** and H. **Whitaker**: A new method of determining the vapour pressures of aqueous solutions. This consists in suspending a droplet of solution from a fine silica spiral microbalance and measuring its weight when it has come into equilibrium with a solution of known vapour pressure placed in the balance case. Preliminary measurements with droplets of solutions of sulphuric acid surrounded either with sucrose solutions or with partially dehydrated oxalic acid have shown that the method is capable of giving accurate results.—B. A. **Burrell**: Atmospheric pollution in Leeds, 1922–25.—E. **Percival** and H. **Whitehead**: Biology of the mayfly *Ephemera Danica*, Müll. Observations have been made on the conditions under which *E. danica* exists. The nymphs are largely confined to sandy deposits where the particles consist chiefly of the coarse and fine sand fractions. The insects are positively rheotactic, negatively phototactic, and, in the light, burrow rapidly. These responses, along with poor swimming powers, tend to limit the distribution of the animals to the sandy regions of streams. An attempt has been made to relate quantitatively the occurrence of these nymphs with their habitat.—J. H. **Priestley**: The relation of cork formation to the endodermis in the shoot of the dicotyledon. An account is given of the occurrence and distribution of the polyderm in the shoot of *Rubus Idæus*, and of the suberised layers in the stem of *Camellia japonica*. In the light of these facts the distribution of cork in Camellia, superficial below the bud scale scars and pericyclic elsewhere in the axis, and the extent of the formation of wound cork in both stems, becomes intelligible. No interpretation of the influence of suberised endodermal structures upon cork formation in the dicotyledon shoot will be possible except upon the basis of detailed studies of this type.

MELBOURNE.

Royal Society of Victoria, November 4.—O. W. **Tiegs**: Metamorphosis of insects. Different degrees of metamorphosis are exhibited by different groups of insects. In dragon-flies there is probably but little change; in coleoptera there occurs a partial tissue disruption, and a partial tissue rejuvenation; in muscid flies a very profound tissue disruption occurs; but the most profound metamorphosis yet described occurs in the chalcid wasp (Nasonia), where *every* specialised larval cell disintegrates at metamorphosis, and, after removal by phagocytes, or after simply dissolving in the blood, is replaced by imaginal cells. In Nasonia the death of the larval cells is not due to phagocytic action, but is a direct consequence of their enormous growth in size, increase in the size of the larva being the result, not of an increase in the number of larval cells, but of an increase in their volume.—A. J. **Ewart** and Lesley R. **Kerr**: Contributions to the flora of Australia (No. 32). The paper contains a number of additions to the flora of the Northern Territory. *Euphorbia petala* n. sp. is related to *E. alsiniflora* and *E. Drummondii*; *Indigofera uncinata* n. sp. is a xerophytic adaptation of *I. australis*. *Eucalyptus Gillenii* n. sp. from the summit of Mount Gillen is related to *E. Oldfieldii*; *Velleia prostrata* n. sp., while related to *V. perfoliata*, has the bracts practically free at the base instead of connate. The collection of abundant material of Ptychosema in all stages of development has made it clear that this genus, and also Lamprolobim, belong not to the Galegeæ but to the Genisteæ.—J. M. **Baldwin**: The technique of the Nanson preferential majority system of election. This system of election, in contrast to other majority systems, fulfils the fundamental condition of majority representation, namely, that a candidate who could beat each of the other candidates separately must be elected. The technique evolved reduces the work of scrutineering to within practical limits. The technique developed has been tested in practice, the time for the tabulation being $Nn(n-1)/1000\ m$ hours (N voters, n candidates, m scrutineers). A method for reducing the number of candidates to ten is suggested which, while not rigidly accurate, is so unlikely to lead to error that the possibility may be neglected.

VIENNA.

Academy of Science, November 4 and 11.—J. **Zellner**, K. **Knie**, E. **Rosenbluh**, M. **Stein**, and J. **Richling**: Contributions to comparative vegetable chemistry (xv.). Chemistry of barks (fifth communication). Acer, Cratægus, Pavia, and Picea have yielded various substances, including ceryl alcohol, palmitic and stearic acids, invert sugar, tannins, etc.—J. **Zellner**, E. **Huppert**, R. **Klapholz**, K. **Knie**, O. **Pollatschek**, A. **Spitzer**, J. **Richling**, and M. **Stein** (xvi.): Chemistry of plants with milky sap. The juices of seven species of the chicory family were found in qualitative agreement containing caoutchouc, two stearin-like alcohols, lactucerol and other substances.—E. Feyertag and J. Zellner (xvii.): *Rhododendron hirsutum*.—J. Zellner: Chemistry of Halophytes. Those on the eastern shore of the Neusiedler See near Vienna are rich in sulphates.—R. Seka and O. Schmidt: Nitro-derivatives of dinaphtanthracene-diquinone and their transformations.

Diary of Societies.

SATURDAY, JANUARY 1.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. V. Hill: Nerves and Muscles: How we Feel and Move: (3) The Heart and some other Muscles.

MONDAY, JANUARY 3.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 3.30.—F. Rodd: Camels and Caravans (Christmas Lecture for Young People).

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Capt. T. W. E. Higgens: Man and his God: The Origin of Religion in the Gentile World as taught by St. Paul.

INSTITUTION OF AUTOMOBILE ENGINEERS (Western Centre) (at Merchant Venturers' Technical College, Bristol), at 6.45.—Prof. W. Morgan: The Optical Indicator as a Means of Examining Combustion in Internal Combustion Engines.

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.—J. H. Coste and Col. Butler: Modern Developments in the Treatment of Sewage.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—B. Anrep: Mosaics.

TUESDAY, JANUARY 4.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. V. Hill: Nerves and Muscles: How we Feel and Move: (4) The Lungs and Blood: How the Muscles get Air and Fuel.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Society of Arts), at 7.—Dr. B. A. Keen: The Place of the Tractor in Soil Cultivation.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—M. Adams: Impressions of America and Canada—Photographic and otherwise.

HULL CHEMICAL AND ENGINEERING SOCIETY (at Hull), at 7.45.—G. H. M. Hutchinson: Refrigeration.

INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Graduates' Meeting) (at Broadgate Cafe, Coventry), at 7.45.—W. N. Haynes: Recent Developments in Motor Cycle Engine Design.

WEDNESDAY, JANUARY 5.

ROYAL SOCIETY OF ARTS, at 3.—Prof. C. R. Darling: The Story of a Wireless Valve (Dr. Mann Juvenile Lectures) (1).

PHILOSOPHICAL SOCIETY OF ENGLAND (at 123 Piccadilly), at 4.30.—Rev. J. B. Jaggar: The Philosophy of Faith.

GEOLOGICAL SOCIETY, at 5.30.—C. S. Elton: The Nature and Origin of Soil-Polygons in Spitsbergen.—Dr. F. Dixey: The Tertiary and Post-Tertiary Lacustrine Sediments of the Nyasan Rift-Valley.

ROYAL SOCIETY OF MEDICINE (Comparative Medicine and Tropical Diseases and Parasitology Sections), at 5.30.—Discussion on Trypanosomiasis in Man and Animals.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—G. H. Nash and others: Informal discussion on The Acoustic Problems of Microphones and Loud-Speakers.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (at Caxton Hall), at 7.—R. E. Herring: The Supervision during Erection and Maintenance of a Low Pressure Hot Water Heating Apparatus.

ROYAL MICROSCOPICAL SOCIETY (Biological Section).

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Middlesbrough Branch, Graduate Section) (at Middlesbrough).—C. Boast: Marine Condensing Plant.

THURSDAY, JANUARY 6.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. V. Hill: Nerves and Muscles: How we Feel and Move: (5) Nerves and Muscles Working Together.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—A. R. Cooper: Electrical Equipment of Track on the Underground Railways of London.

INSTITUTION OF THE RUBBER INDUSTRY (Birmingham and District Section) (at Grand Hotel, Birmingham), at 7.—A. W. T. Hyde: Physical Tests and their Significance.

SOCIETY OF CHEMICAL INDUSTRY (Bristol Section, jointly with Fuel Section) (at Bristol University), at 7.30.

SOCIETY OF DYERS AND COLOURISTS (West Riding Section) (at Bradford).—Prof. F. M. Rowe: Soledon Colours (SDC) and their Development on Cotton and Wool.

INSTITUTION OF MECHANICAL ENGINEERS (Manchester Branch) (at Manchester).—R. Potter: Pulverised Fuel.

FRIDAY, JANUARY 7.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 3.30.—J. H. Reynolds: A Little Journey in the Kingdom of Iceland (Christmas Lecture for Young People).

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Engineering and Scientific Club, Wolverhampton), at 7.—W. Wilson: Electrical Research.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—Dr. C. H. Lander: Developments in the Carbonisation of Coal.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.

PHOTOMICROGRAPHIC SOCIETY (at 4 Fetter Lane), at 7.—F. Martin Duncan: Notes on the Photography of Plant Tissues.

SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (at 16 St. Mary's Parsonage, Manchester), at 7.—Short Papers.

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—P. J. Haler: Distortion in Heat-treated Case-hardened Carbon Steels.

SATURDAY, JANUARY 8.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. V. Hill: Nerves and Muscles: How we Feel and Move: (6) Speed, Strength, and Endurance.

CONFERENCES.

ANNUAL CONFERENCE OF EDUCATIONAL ASSOCIATIONS (at University College).

Thursday, December 30, at 3.—Sir Henry A. Miers: The Choice of What is Good for Others (Presidential Address).

Friday, December 31, at 11.30 A.M.—Earl of Clarendon: Empire Settlement and Development.—King Alfred School Society, at 3.—J. Wicksteed: The Evolutionary Value of Co-Education.—Royal Drawing Society, at 5.30.—H. H. Peacock and P. Griffith: The Education and Development of Æsthetic Ability in Young People.

Saturday, January 1.—Educational Handwork Association, at 2.—J. H. Everett: The Teaching of Practical Elementary Science.—Leplay House, at 3.—Discussion: The Periodical Observation. Its Use for Observational and Regional Survey Work.—International Language (Ido), at 5.—G. H. Richardson: International Language. The Present Situation and the Prospect.

Monday, January 3.—Eugenics Society, at 11 A.M.—Prof. E. W. MacBride: The Nature and Origin of Racial Differences.—British Psychological Society (Education Section), at 6.—Discussion: S. J. F. Philpot, Miss Barbara Low, and others: The Cinema in Relation to the Mind of the Child.—British Association for Physical Training, at 5.30.—C. S. Thomson: Hygiene and Physical Training.

Tuesday, January 4.—School Nature Study Union, at 5.—Dr. E. J. Salisbury: Salt Marsh Vegetation.

Wednesday, January 5.—Society for Experiment and Research in Education, at 10.30 A.M.—J. H. Whitehouse and others: Creative Education.—Child Study Society, at 5.30.—Miss Lilian Barker: The Girl Delinquent.—British Esperanto Association, at 5.30.—Rev. Prof. T. G. Bailey: Esperanto in the World to-day.

Thursday, January 6.—National League for Health, Maternity, and Child Welfare, at 5.—Miss Gardiner, Dr. R. J. M. Horne, and others: Discussion: Open Air Schools.—London Head Teachers' Association, at 5.—W. A. Brockington and Prof. Godfrey Thomson: Technique of Examination.

Friday, January 7.—British Broadcasting Company, at 11 A.M.—J. C. Stobart and others.

GEOGRAPHICAL ASSOCIATION (at London School of Economics, Houghton Street, Aldwych, W.C.2).

Thursday, January 6, at 11.30 A.M.—Major C. Patrick: Mapping from Air Photographs.—At 5.—Miss Eileen Power: Trans-Asiatic Caravan Routes in Ancient and Modern Times.—At 8.—J. Fairgrieve: Geography Teaching in Primary Schools.—Sir Henry G. Lyons: Geography in the Universities.

Friday, January 7, at 10 A.M.—Prof. H. J. Fleure: The Teaching of Geography.—At 11.45.—Sir C. F. Close: Population Problems of the Empire (Presidential Address).—At 2.—Col. Jack: The Work of the Ordnance Survey Department.

Saturday, January 8, at 10 A.M.—Prof. T. P. Nunn: Boy Scout Geography.—At 11.30.—Mrs. Ormsby: Regional Survey in a Large City.

JANUARY 3 AND 4.

MATHEMATICAL ASSOCIATION (Annual Meeting) (at London Day Training College).

Monday, January 3, at 5.30.—Prof. R. W. Genese: An Elementary Exposition of the Methods of Grassmann.

Tuesday, January 4, at 10.30 A.M. to 12.30.—Prof. M. J. M. Hill: The Teaching of Mathematics (Presidential Address).—Prof. A. Lodge: The Importance of including in School Work the Graphic Solution of Quadratic Equations.—G. Goodwill and others: Discussion on The Choice of Units in the Teaching of Mechanics.—A. C. Heath: On the Approximation to Irrational Numbers by Rationals.—At 2.30 to 4.15.—Prof. H. F. Baker: Can the Range of Geometry taught in Schools be Widened?—W. C. Fletcher: Geometrical Congruence.—A. T. Edwards and others: Discussion on The Relation of Art to Mathematics.

EXHIBITION.

JANUARY 4, 5, AND 6.

SEVENTEENTH ANNUAL EXHIBITION OF THE PHYSICAL SOCIETY AND THE OPTICAL SOCIETY (at Imperial College of Science and Technology, South Kensington), from 3 to 6 and from 7 to 10.

January 4, at 8.—Prof. E. N. da C. Andrade: Reproduction, with Contemporary Apparatus, of a Physical Lecture of the Early Eighteenth Century.

January 5, at 8.—Dr. C. V. Drysdale: A Lecture on Progress in Electrical Instrument Design and Construction.

January 6, at 8.—J. L. Baird: A Lecture on Television.

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SATURDAY, JANUARY 8, 1927.

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Forest Destruction and its Effects.

THE question of the action of forests on rainfall has been debated by foresters, agriculturists, engineers, and others for a long period, the discussion probably dating back to the time at which scientific forest conservancy was first introduced. In the tropical and sub-tropical parts of the world this is not, however, the point of primary importance. The vital factor for the community at large is the determination of how far the destruction of forests in catchment areas and on the sides of hills and mountains in the drier parts of a country affects, in the first place, the level of the water in the big rivers, a matter of extreme importance when the rivers are utilised for irrigation or power works; secondly, the decrease in the local water supplies and in local precipitations upon which the cultivator is dependent; and, thirdly, erosion and avalanches, and the destruction they cause in the fertile valleys beneath. Sudden floods may also cause enormous damage to railways, towns, and so forth. In India, which was the first part of the British Empire to give consideration to this aspect of the forest question, the matter has been the subject of discussion and reports through the whole of the past century, a statement which will perhaps come as a surprise to many in Great Britain.

The problem of affording protection to forests for the above causes alone is by no means new. In France and Germany special laws for the protection and extension of the forests and the protection of agricultural lands by means of the forest have long been in operation; and similar laws exist in the Italian States. So far back as 1475 the subject attracted the attention of the famous Venetian Council of X., by whom a law was passed on January 7 of that year, regulating in great detail the clearance of the forests on *terra firma*. The mountain forests especially were protected by judicious regulations, which were renewed from time to time down to the very year of the extinction of the old republics. Tuscany and the Pontifical Governments were equally provident.

History has since shown that the wholesale destruction of forests in Spain, Italy, Sicily, Greece, and Macedonia has resulted in a great deterioration of climate over considerable tracts, due to loss of moisture, the sterilisation of the soil, and excessive erosion.

Although now well known, the chief action of the forest may be stated briefly as follows: The great factor in mountainous and hilly country is the maintenance of tree growth on parts of the area. In the case of bare slopes the rain rushes rapidly down, causing erosion, only a fraction percolating into the soil, and is carried rapidly away, giving rise to spates and perhaps to serious floods, since the old channels of these streams or rivers are no longer able to carry the excess water of flood levels. A hot sun bursting out on to the slope after the rain quickly dries up the thin layer of moisture covering it. In the hotter parts of the globe subject to heavy rainstorms or monsoons the rushing water starts gullies which eventually become ravines, all surface soil is rapidly washed away, and in the course of years the hillside is eaten into, rubble and boulders being sent down to cover up valuable lands below. When the area is under trees, a portion of the rain, falling on the crowns, drips slowly down on to the layer of humus beneath and sinks into it. The larger portion, perhaps, falls direct on to the forest floor, where it is gradually absorbed in the soft covering which takes it up as a sponge. The water then percolates slowly downwards, filling up springs and underground reservoirs, and reaches the streams in a retarded manner. The flow in the latter is consequently more even and regulated, as also the amount of water which eventually reaches the rivers. The latter can therefore be more depended upon to maintain a normal level when it is required to utilise them for irrigation or power works. The roots of trees protect the surface by holding up the soil, and thus directly prevent denudation.

It is possible to give some concrete examples of the effects of the destruction of teak forests in India during the first half of last century, owing to the large demands for this timber from rapidly expanding markets.

The slopes on the west coast of the Bombay Presidency were once, even in the early days of British occupation, covered with magnificent, valuable, and extensive teak forests. These have long since been cut out, some disappearing for good. The denudation of the Deccan Highlands and the Eastern Ghâts has resulted in excessive erosion and the gradual silting up of the rivers. When the Dutch, French, and English first built settlements on the Coromandel Coast, it was possible to take ships up the Godaveri and Kistna. The English port of Narasapur and the French one of Yunaon, both on the Godaveri, were once the chief ports on this coast. They can now be reached only at high tide by small native shallow-draught craft. Last year the present writer had arranged to go down the Godaveri from Sironcha, on the frontier of South Chanda (Central Provinces) and the Hyderabad State, to Rajamundri, as he wished to carry out investigations in connexion with the effects of forest denudation on this river. It was early in March, the commencement of the hot weather season only. Inquiries elicited the fact that few rafts were now going down, owing to the extensive sandbanks already drying off in the river, and that even by dugout canoe, delays from stranding on sandbanks would be inevitable. Some hundred years ago this great river was the chief artery or high road into the interior! At Masulipatam, Dutch ships used to ride at anchor close up to the port, whereas at the present day even small native vessels have to anchor five miles out in the roads owing to the silting up. Between 1840 and 1850, Dr. Gibson, the first Conservator of Forests in Bombay, drew up a list of the rivers and creeks on the Malabar coast, where on arrival in those parts ships used to ride at anchor, all the creeks having silted up within the memory of men then alive.

Dr. Cleghorn, who afterwards became the first Conservator of Forests in Madras, directed attention to the destruction of tropical forests at the meeting of the British Association in Edinburgh in 1850. A committee was appointed to consider this matter. Dr. Cleghorn submitted its report, which was confined to India, the only country for which information was available, at the meeting of the Association at Ipswich the following year. The report summarised the position, as then known to the few in India who had given attention to the matter, pointing to the great and uncontrolled destruction which was taking place, both at the hands of timber merchants and owing to the careless habits of the native populations, who grazed their cattle at will in the forests and fired them every year in order to encourage the growth of new grass. The indigenous tribes in the hilly country also practiced unchecked shifting cultivation, a practice second only to the lumberer in the destruction of fine forests. Under this method, which was a common habit in Europe in olden times, a patch of good forest is felled and the material burnt *in situ*; coarse grains are then sown on the clearing. The cultivator then sits down and awaits the harvest. Two or three crops are taken off the area; the weeds then become too strong (as he never troubles to weed) and he moves on to a fresh area. The enormous destruction of virgin forest this practice entails, when practised for centuries, has to be seen to be credited. Yet many of the tropical and sub-tropical forests in British Colonies and Dependencies are still subject to this the most pernicious and precarious form of so-called agriculture (as also to over-grazing and firing), the administrations responsible not having yet, apparently, understood the evils which attend it. The difficulties facing these Governments in prohibiting the practice or controlling it were all experienced in India, in one form or another, and overcome.

The encouragement given to the growth of tea and coffee and similar crops by British administrations in the Empire, whilst eminently praiseworthy if carried out on well-considered lines, has been productive of great harm in the past, and even the present day can scarcely be said to be free from anxiety on this score. In a report written in India in 1876 with reference to coffee planting, the following criticism is made:

> "The planters who come over from Ceylon are now giving a very high price for land, and the whole *mischief may be effected in a very short time*. It must not be supposed that coffee is at all a permanent cultivation; we have only to look at the Sampajee Ghât in Coorg, the Sispara Ghât in the Nilgiris, and parts of the Annamalais to see at once that it is very often very little better than the shifting cultivation of the natives. It pays a coffee planter *to take up a tract of primeval moist forest on our* mountain slopes for a few years; he gets bumper crops the third, fourth, and fifth years, but denudation of the soil and erosion goes on rapidly, and it does not pay him to keep it up many years."

Two other examples may be mentioned. In Ajmere-Merwara in Rajputana, all the waste and forest land was handed over to the people by Government in 1850. The hills were rapidly denuded of timber and grazing was uncontrolled. The crops are irrigated from tanks (ponds) formed by building embankments across ravines. Some of these were very old. The rainfall is scanty and comes in heavy showers. The water, rushing down in torrents, quickly eroded the denuded hillsides, the tanks filled up with silt and debris or the embankments burst. In 1869, at the end of a two-year famine, the region was described as follows: "The cattle had perished, the people had fled, large villages were entirely deserted and the country was almost depopulated." All this was due to the mistaken policy of giving to the people what they had clamoured for, the uncontrolled use of the forest lands. An even more classic example is that of the well-known Hosiarpur *Chos* in the Punjab. These hills were formerly fairly well wooded. A rapid increase in population followed the advent of British administration in 1846. The consumption of forest produce augmented, the herds of grazing cattle multiplied excessively, and complete denudation ensued. This was followed by erosion, broad stretches of sand invading the plains beneath, with the result that the arable lands of 940 once prosperous villages were covered with sand, which laid waste upwards of 70,000 acres of fertile lands. In 1900 this formerly rich district was traversed by numerous broad, parallel, sandy belts cut out of the crop-bearing and fertile area.

In India these matters are now well understood, and the Forest Department, supported by the Government, has control of the great forest areas. Proofs of the disadvantages and disasters following the uncontrolled wasteful utilisation of the forests in mountainous and hilly country are not therefore wanting. It is known that the same processes are at work, and the same mistakes are being made, in our Colonies. It is the habit of British *administrations to work in water-tight compartments*. Probably the major portion of the difficulties being experienced in different parts of the Empire have been solved, or are approaching solution, in one or other of the provinces in India. They present no new features, as some appear to think, as the above-quoted examples go to prove. The chief difficulty is that action is delayed until almost irretrievable damage has been done and then the forester is asked to reafforest the areas so denuded. This entails an enormous expenditure, great skill, with success ever hanging in the balance.

Attention was directed to this subject at the meeting of the British Association in Edinburgh in 1920, when a paper dealing with the Indian forests was read. Resolutions of the same kind were also passed by the World's Forestry Congress held at Rome in May 1926. As an outcome of last year's meeting of the British Association at Oxford, the chairman of the Forestry Sub-Section, Lord Clinton, drew up for the council a brief statement dealing with the destruction of forests on hill slopes, with special reference to the tropical forests of the Empire. This memorandum has been submitted to the Secretary of State for the Colonies, by whom it is being communicated to the Colonies and Protectorates. It may be hoped, therefore, that the chief factors of destruction, namely, shifting cultivation, excessive grazing and the firing of forest lands, may receive that measure of considered control which the expert forestry services under the Colonial Office are fully capable of inaugurating if supported by the several administrations.

Racial Likeness.

Biometrika. Vol. 18, Parts 1 and 2. (London: Galton Eugenics Laboratory, University College, 1926.)

THIS instalment of *Biometrika* presents a strong claim on the interest of students of physical anthropology centred in the account which Prof. Pearson gives of the "Coefficient of Racial Likeness." This is a single numerical expression designed to measure the degree of resemblance (or divergence) of two groups of mankind. While this coefficient is the chief feature of research described in these memoirs, there is a second which should not be overlooked. The latter is an expression measuring the degree of resemblance of two groups in respect of a single character. It differs consequently from the coefficient of racial likeness, which sums up evidence furnished by a number of contributory characters.

Miss Hooke is responsible for the first paper, entitled "A Third Study of the English Skull." The previous studies were made by Dr. Macdonell (*Biometrika*, vol. 3, p. 191, and vol. 5, p. 86) upon human skulls found in London, the first series coming from Whitechapel, and the second from Moorfields. Both were regarded justifiably as representative of Londoners of the seventeenth century. Miss Hooke disposes of a collection of skulls from Farringdon Street, and refers them to the seventeenth century likewise. Tables of measurements supplement the descriptions, while type-contours extend the basis of comparison with other groups. The coefficients of racial likeness have been determined, and when the results of comparing the Farringdon Street groups with those from Whitechapel and from Moorfields in succession are surveyed, the conclusion is reached that "the three are very similar, but not sufficiently so to warrant the assumption that they are drawn from a single homogeneous population" (p. 102). Resemblance is discovered between the Farringdon Street skulls and certain Scottish skulls, but marked divergence from the skulls at Rothwell, Northants, measured and described by Prof. Parsons.

Dr. Morant contributes the second paper, reporting his inquiry into the characters of British crania at different historical epochs. First he reviews representatives of the Long Barrow (neolithic) population, followed in succession by those of the Bronze Age, the Iron Age, and the Anglo-Saxon period of dominance. The survey of these groups includes references to the arithmetical means of the measured characters, to the coefficient of racial likeness, to the coefficient termed 'α' (which measures the degree of likeness in respect of any single character), to measures of variability, and to type-contours. Discussion of the conclusions is carried into the next memoir.

This paper contains the observations made by Miss Hooke and Dr. Morant conjointly on the conclusions to which their researches have led them. The ascertained values of the coefficient of racial likeness are brought together impressively in Table I. One coefficient is particularly remarkable, by reason of the emphasis it lays upon resemblance. The resemblance thus emphasised is that of the Whitechapel skulls to the British Iron Age skulls. This resemblance surpasses in closeness everything else in the table.

The fourth paper is by Prof. Pearson himself. He recalls the difficulty of comparing two groups of mankind when the numbers of one or both are relatively small. He points out the difficulty of summing-up on the results of comparing characters one by one. He describes steps leading to a formula capable of measuring the degree of resemblance (or divergence) of the two groups. This formula he terms the coefficient of racial likeness; and (in regard to its indications) the nearer the numerical value is to zero the more closely associated are the two groups, in the sense that they are more probably samples of the same population.

Prof. Pearson has at his disposal no less than 757 coefficients of racial likeness. Their numerical values range widely, 110 of them being less than unity, while 39 are higher than 31. Prof. Pearson suggests a classification with twelve subdivisions called grades. In Grade I. are all coefficients less than unity. They denote very intimate association. At the other end of the scale is Grade XII., including all coefficients in excess of 31, indicating very wide divergence. A boundary is fixed arbitrarily at the number 13, and this is to mark the extreme limit at which resemblance can be claimed.

The series of coefficients is next reviewed; and in regard to those with high numerical values indicative of wide divergence, Prof. Pearson is able to claim that in the vast majority of the instances available the coefficient brings confirmation to conclusions formed on independent grounds. In a corresponding manner, when scrutiny is directed to the coefficients denoting very intimate association, it is difficult to find any pair of groups "which embraces two craniologically distinct races" (p. 114). Such facts ought to establish confidence in the intermediate values and indications of the coefficient. Of these values it is remarked that some are in their purport entirely novel, while others correct views held previously as to the relation of certain groups of skulls. One of the four examples illustrating these conclusions proclaims that the English skull is nearer to that of the men of the British Iron Age than to that of the Anglo-Saxons. The conclusion reached by Miss Hooke and Dr. Morant in regard to the close association of the Whitechapel series and the British Iron Age skulls has been mentioned already. Here the setting is slightly different, and the relevant coefficients are adduced in support of the conclusion which it embodies.

Turning to the records, it appears that in association with the seventeenth century English (Whitechapel series) the British Iron Age skulls yield a coefficient of 0·38, whereas with the same English series the Anglo-Saxon skulls yield a coefficient of 2·98. At this point it is worth recalling that in 1904, when dealing with the Whitechapel and Moorfields series, Dr. Macdonell found confirmation of the suggestion made by Prof. Pearson that the Whitechapel skulls are closer to the Long Barrow British than to the Round Barrow British, Romano-British, Anglo-Saxon or "mediæval English" represented in the museums of this country. About sixteen years later, Prof. Parsons urged the claims of the Anglo-Saxon skull in this respect, against those of the Long Barrow skull. The evidence of the coefficient of racial likeness acquires a special interest in view of this difference of opinion, and the present series of memoirs provides the following data upon this subject.

COEFFICIENTS OF RACIAL LIKENESS.

Whitechapel and British Iron Age	0·38 ± 0·20
Whitechapel and Moorfields	2·05 ± 0·18
Whitechapel and Anglo-Saxon	2·98 ± 0·19
Whitechapel and Farringdon Street	4·15 ± 0·18
Whitechapel and Long Barrow (p. 100)	7·44 ± 0·18,
(or p. 55)	3·71 ± 0·18

The coefficient consequently places the British Iron Age skulls closest to the Whitechapel skulls. Thus it displaces both the Long Barrow skulls and the Anglo-Saxon skulls from the distinctive position claimed for them by their respective advocates. The data illustrate also the varying values of the coefficient resulting from the comparison of the Whitechapel series with each of the two other seventeenth-century series of Londoners.

Returning now to Prof. Pearson's paper, it will be found that he discusses the influence exerted upon the value of the coefficient by the number of the skulls available in the groups compared with each other, and again by the number and also the character of the observations employed. A plea for standardisation in these matters is also advanced by Prof. Pearson.

The application of the coefficient of racial likeness to the series of British crania has been taken above as an appropriate illustration. But although the associations there indicated and their grading may be novel, they are neither impossible, nor even extremely improbable. With such reflections in mind, attention is directed to the remarkable association assigned to Mori-ori and Fuegian skulls by the corresponding coefficient. Almost equally strange is the association indicated as existing between his Mori-ori (non-Mongolian) Tibetans.

The perusal of the list of records leaves a certain impression of caprice in the manifestations of the coefficient of racial likeness. For example, in one and the same population, namely, Londoners of the seventeenth century, the coefficient may range from 1·41 to 4·85 for male skulls and from 0·96 to 5·77 for female skulls, according to the characters employed and the pairs of groups compared. Again, the comparison of various pairs of Romano-British groups yields a range of the coefficient from 0·5 to 17·48. These records must needs be borne in mind and the explanations carefully weighed before the very striking values of the coefficients relating to Tibetans, Mori-ori, and Fuegians are made the basis of arguments affecting the movements of human racial types. At present, caution enjoins reliance upon the coefficient only where its numerical values are extreme (whether low or high) and its emphasis (whether laid upon resemblance or divergence) correspondingly pronounced.

In the fifth paper, Dr. R. W. Reid, emeritus professor of anatomy in the University of Aberdeen, describes two skeletons from St. Magnus Cathedral, Kirkwall, Orkney. The Icelandic Sagas and the Orkneyinga Saga provide Dr. Reid with evidence that the patron saint was executed (murdered is more correct), that the executioner used an axe, that after interment for twenty years the body was enshrined over an altar in Christ's Kirk, Birsay, and that after a sojourn there and in another church, the shrine was transferred to the cathedral. From the same sources Dr. Reid has ascertained that the body of the famous Norse St. Rognvald was buried likewise in the cathedral (of which he was actually the founder).

Each skeleton occupied a recess curiously excavated high up in a pillar of the choir of the cathedral. Dr. Reid comes to the conclusion that the remains from the south pillar are those of St. Magnus, and that those in the north pillar probably belonged to St. Rognvald. The osteological descriptions are accompanied by tables of measurements and by contour tracings.

Dr. Reid's conclusions make as close an approach to absolute identification as can be expected in the circumstances. Although not actually brachycephalic in terms of the proper index, both skulls by reason of their width tend in that direction. This point is mentioned in view of an opinion, based on experience elsewhere, to the effect that this tendency is very frequently to be remarked in the skulls of medieval ecclesiastics.

The photographs of the skull assigned to St. Magnus suggest the possibility that two kinds of mutilation, effected at different epochs, are present. It seems not impossible that a spade may have inflicted supplementary injuries now indistinguishable from those due to the executioner's axe twenty years earlier. The difficulty of the problem has long been recognised, and a discussion thereof will be found in the "Collected Scientific Papers and Addresses" of the late Prof. Rolleston (vol. 1, p. 286). W. L. H. D.

Archæology of Iron.

Iron in Antiquity. By Dr. J. Newton Friend. Pp. viii+221. (London: Charles Griffin and Co., Ltd., 1926.) 10*s.* 6*d.* net.

THE application of the analyses of metal objects to the study of archæology, especially in connexion with the problems of the bronze age, is becoming increasingly important owing to its bearing upon questions of cultural diffusion. If, for example, it were possible to determine by analysis the origin of the copper found in the various centres of early culture in which copper did not occur or had not been mined but had to be imported, we should probably be well on the way to solving some of the more obscure questions of pre-history. The work of the committee of the British Association which is seeking the source of Sumerian copper on these lines, when completed, may be expected to indicate how far such research is likely to be of practical utility in furnishing evidence in archæological and ethnological argument. This point is not without interest in the present connexion, as Dr. Friend, whose competence as an archæologist and metallurgist has been proved in a number of communications to the technical journals, in his "Iron in Antiquity" has not confined his attention to the study of that metal alone. He has felt it incumbent upon him to survey briefly the technological side of the stone, copper, and bronze ages, and has thus put readers who may not be archæologists in possession of the facts which are necessary to an understanding of the special problems with which primitive users of iron had to deal. Further, he refers incidentally to the arguments relating to the diffusion of culture which have been based by Prof. Elliot Smith upon the early use of copper in Egypt.

As regards the beginnings of iron, Dr. Friend is of the opinion that meteoric and not telluric iron was the form in which it was first used. The figures he quotes in reference to the amount of meteoric iron which probably was available for the use of early man appear adequate to meet the arguments of those who hold otherwise. It would have been an advantage had the primitive furnace, especially as it occurs in Africa, received a little more detailed treatment. It would then have been more clearly apparent that the process of smelting iron is one which presented no very great difficulty to primitive man. It would seem, however, that both early and primitive peoples were not fully capable of dealing with the product of the furnace. While the Vikings, for example, were able to produce satisfactorily an object of some size, such as an anchor, a thin strip of metal such as a sword, which would retain an edge and not bend, was frequently beyond their powers. The regular occurrence in sagas and legends of swords of fame each with its own special name is some measure of the difficulty the smith experienced in producing a satisfactory weapon. In its rarity it called for special commemoration. References to the ease with which the spears of African natives were bent are frequent.

Dr. Friend gives some interesting details relating to the quality and character of the metal in iron objects found in pre-Roman and Roman Britain. It is noteworthy that samples of Roman iron which have been tested for corrodibility compare favourably with modern mild steel of corresponding size.

Although Dr. Friend's collection of data from various sources is admittedly not exhaustive, as supplemented by his own observations and researches, it will be of very real assistance to students of archæology. The results of the qualitative and quantitative analyses are particularly useful and frequently illuminating. All sides of the subject are covered. The author touches upon the various uses to which iron was put—for ornament or for currency as well as for implements and weapons — whether it be in the prehistoric period, in early Egypt and Mesopotamia, India, China and Japan, or among primitive peoples. It may, however, be said in passing that the chapter on Africa is scarcely adequate in view of the importance of iron-working in that continent and the amount of information about it which has been collected in recent years; and more attention might well have been given to China and Japan. Dr. Friend has not omitted to mention the interesting religious beliefs and superstitions which attach to iron, the avoidance of its use for ceremonial purposes, and the attribution of a magical character to the smith. A striking example to which he might perhaps have directed attention is found in the avoidance customs which affect the relations of the general population with the iron-working tribes who are responsible for the supply of weapons in certain parts of East Africa; while in England, in addition to Wayland the smith, we have a good example of the smith-magician in that curious folk-song of the "Coal-Black Smith." Nor does he allude to the significant variant of the 'fairy-wife' folk-tale, once current in

Wales, and elsewhere, in which the wife vanishes when struck by iron.

As Dr. Friend does not confine himself entirely to the subject of iron, it may not be out of place to allude to one or two points in connexion with copper. The statement is repeated that Africa, excepting Egypt, had no copper and bronze age but passed directly from stone to iron. No doubt this is true generally; but no mention is made of the vast amount of copper which has been taken from the ancient workings in Rhodesia and the Katanga. Even now in Rhodesia the natives smelt copper in primitive furnaces. What was the destination of all the copper from these early workings, which has been estimated at an enormous number of tons? It is urgently necessary that the dumps at the ancient mines should be examined for evidence of date before they disappear in the course of the mining operations of to-day. A committee of the British Association has been appointed with the view of following up clues furnished by objects which have come into the possession of the mining companies; but whether anything can be done must depend to a great extent on the possibility of raising funds for the prosecution of inquiries on the spot.

Another curious point arises in connexion with the water-clocks in the form of a perforated bronze bowl which have been found at Wookey Hole and elsewhere. Dr. Friend is of the opinion that they are a British invention, although they occur in India and Ceylon presumably at a later date. Apparently he is not aware that they occur in Algeria also. What adds to the interest of this fact, but by no means makes it easier to explain, is that there also occurs in Algeria a primitive form of lathe which is identical in form with the lathe used in the peasant cottage-industry of wood-turning in Buckinghamshire.

The New Thermodynamics.

The New Heat Theorem: its Foundations in Theory and Experiment. By Prof. W. Nernst. Translated from the second German edition by Dr. Guy Barr. Pp. xvi+281. (London: Methuen and Co., Ltd., 1926.) 12*s*. 6*d*. net.

ONE of the most important branches of thermodynamics as applied to chemistry is the relation of heat of reaction with chemical equilibrium data and the calculation of the effect of temperature on the equilibrium constant. The fundamental equation here is that first deduced in its present form by van 't Hoff in 1884:

$$d \log_e K / dT = Q/RT^2,$$

where K is the equilibrium constant, Q the heat of reaction, T the absolute temperature, and R the gas constant. The effect of temperature on Q was known previously in the relation deduced by Kirchhoff, and special cases of the above equation had been used by Horstmann, Gibbs, and others. This is a differential equation, and its integration necessarily introduces an arbitrary constant, the value of which could be found only by experiment. It is the discovery of Nernst, published in 1906, and generally known as Nernst's theorem, which enables one in many cases to find the integration constant without any information as to the states of equilibrium. This is the practical aspect of the theorem, and it will be realised that it opens out important fields of application both in the laboratory and in industry.

In the shape used by Nernst, the maximum work, or diminution of available energy, is correlated with the heat of reaction in a form which is a consequence of van 't Hoff's equation, but Planck has shown that the content of the theorem can also be expressed in the statement that the entropy of every pure solid substance vanishes at the absolute zero. The entropy has been related to molecular statistics by Boltmann, Gibbs, and Planck, and in this field the quantum theory has found its place. It is therefore clear that an entirely new branch of the theory of heat has been created in recent years, and it is possible to speak of the 'New Thermodynamics' as distinguished from the classical science evolved from the work of Joule and Carnot by Lord Kelvin, Clausius, and others.

The book under notice is Prof. Nernst's own version of the new theory and of the experiments which have gone so far towards its verification. It is written in the style associated with its author; there is nothing superfluous and the mathematical apparatus is kept in its proper place. The translation has conveyed the spirit as well as the content of the original extremely well, and the book is one which ought to be a welcome addition to the library of every chemist who has occasion to make use of physical-chemical methods. It must be emphasised that Nernst's theorem has important industrial applications, and that the book is one which will be found intelligible by readers who have only a moderate knowledge of mathematics.

The first part of the book deals with the specific heats of solids and gases, and the experiments which showed that at very low temperatures the specific heats of solids become very small. It was this result which gave such an important confirmation to the quantum theory as applied to material systems. The theory in the case of gases is much less complete, and there is a comparative lack of experimental data in this field. In Chap. vi. the formulation of the new theorem is dealt with, in a direct and practical manner, and then follows an attempt to explain its physical basis, which is said to be contained in the law that "there cannot be any process taking place in finite dimensions by means of which a body can be cooled to the absolute zero." Important mathematical formulæ used in the applications of the theorem are next summarised, and then the application of the theorem to numerous cases follows in the rest of the book. Complete numerical data, curves, and references to the literature are given.

Perhaps the most interesting part of the book, from the theoretical point of view, is that dealing with the calculation of the chemical constants, which, together with thermal data, are required in the applications of the theorem. It cannot be said that this branch of the subject is yet in a very advanced state, but sufficient is given to enable the reader to understand the nature of the problem to be solved. J. R. P.

Our Bookshelf.

The Importance of Diet in relation to Health. (The People's League of Health Lectures.) Pp. xii + 130. (London: George Routledge and Sons, Ltd., 1926.) 3*s.* 6*d.* net.

THE subject matter of this book consists of a course of six lectures entitled "What to Eat and Why," given, under the auspices of the People's League of Health, by a distinguished group of lecturers.

In the first lecture, on "The General Principles of Diet," Prof. Leonard Hill points out the importance of diet, sunshine, and open air in the prevention of tuberculosis and rickets. Overfeeding is stressed as being the most general error, caused by the temptation of "the arts of cooking, by pastry cooks and sweet shops." "More people are probably killed off too early by intemperance in eating than by alcoholic intemperance." The food requirements of different classes of individuals are given, and the use and misuse of some of the commoner articles of diet are discussed. The second lecture, on "The Food of Mankind treated Historically and Geographically," by Sir D'Arcy Power, affords an extremely fascinating picture of the habits that have prevailed from the earliest times. The customs of the Egyptian, Grecian, and Roman Empires are compared with those of Anglo-Saxon and Norman times, showing the evolution of present-day usages. The chapter draws an important lesson, showing the relationship of moderation in food to health and character.

Prof. W. D. Halliburton's lecture on "Vitamins and the Diseases caused by Badly Chosen Diet" urges the importance of milk, green vegetables, and whole-meal bread. Many will endorse the lecturer's remark: "Cursed be he who removes his neighbour's landmark, and those who interfere with their neighbours' food ought to be equally banned." But Prof. Halliburton's remark that "It is the poor, whose ignorance leads them to suppose that white bread is the best and whose poverty compels them to eat the cheapest fat," is especially poignant, as we see from the previous lecture that throughout the ages the poorer classes have invariably endeavoured to follow the habits of the more well-to-do.

Dr. H. Scurfield follows with the application of the points already discussed to "Infant Feeding." The figures he has to give concerning the decrease of infant mortality in Great Britain are encouraging and compare favourably with progress made abroad. Dr. M. J. Rowlands explains the importance of "The Feeding and Breeding of Cattle in Relation to the Health of the People." It is pointed out that as vitamins are of vegetable origin, they must be liberally supplied to the cow if the milk is to be of proper quality. This is frequently overlooked, especially in winter feeding. Besides reducing the quality of the milk, the lecturer considers that neglect of these substances is the main cause of bovine tuberculosis. The last lecture, on "Food Preservation and Adulteration," by Prof. W. E. Dixon, is comforting, for he shows clearly that the addition of preservatives is unnecessary for all foods except sausages. Australia and New Zealand send butter to the United States, where added preservatives are absolutely forbidden, so they can quite easily provide us with the same quality.

The whole book is extremely readable and interesting, and should be widely studied by those interested in welfare work.

Acoma, the Sky City: a Study in Pueblo-Indian History and Civilisation. By Mrs. William T. Sedgwick. Pp. xiii + 314 + 33 plates. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1926.) 18*s.* 6*d.* net.

ACOMA, a pueblo stronghold of the Keres people of New Mexico, has a double claim on the interest of the student. Its inhabitants, now about five hundred in number, are the least known, the most reticent, and the most inscrutable, of the Indians of the pueblo area. Their history as told in the stories of the conquistadors, the poems of Villagrá, and later records, embodies examples of valour and endurance as striking as any in the history of the Spanish conquest of America. Mrs. Sedgwick has a thrilling story to tell—from the entry of the Spaniards into New Mexico in 1539 and the expedition under Coronado in 1540, when they first saw Acoma, until the final crushing of revolt among the inhabitants of that pueblo in 1699. To the Indians it seemed well-nigh impregnable, as indeed it appears to-day, and its capture was a remarkable feat of arms.

In culture the Acomas are akin to the Zuñi; but even that indefatigable and sympathetic inquirer, Mrs. Elsie Clews Parsons, was to a great extent baffled by the difficulties of obtaining information from them. To give a more or less coherent account of their beliefs and organisation, Mrs. Sedgwick has made use of the analogies of closely related cultures, but only with good reason. In this matter her judgment and her experience among the people themselves may be trusted. Although her account of the Acoma culture is not based entirely or even to a great extent upon first-hand observation, she has done a service both to the student and the general reader in presenting the historical and the anthropological material in an eminently readable form within the covers of one book.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Aurora of October 15, 1926, in Norway and Sounds Associated with It.

SOME curious phenomena accompanying the splendid aurora of Oct. 15, 1926, were observed by me. On the night in question I was working as observer of international determinations of longitude at the top of a hill named Voxenaasen in the neighbourhood of Oslo (approximate altitude, 470 metres). I was at work in a field observatory with a transit instrument registering star transits and chronometer beats for time determinations, when an initial aurora attracted my attention. My assistant was Mr. G. Jelstrup, electrotechnical student.

I was able, during intervals between my observations of time and polar stars, to observe the aurora, which was certainly one of the most splendid I had ever seen. But what is of preponderant interest is the following fact: When, with my assistant, at $19^h\ 15^m$ Greenwich Civil Time, I went out of the observatory to observe the aurora, the latter seemed to be at its maximum: Yellow-green and fan-shaped, it undulated above, from zenith downwards—*and at the same time both of us noticed a very curious faint whistling sound distinctly undulatory, which seemed to follow exactly the vibrations of the aurora.*

The sound was first noticed by me, and upon asking my assistant if he could hear anything, he answered that he noticed a curious increasing and decreasing whistling sound. We heard the sound during the ten minutes we were able to stay outside the observatory, before continuing our observations.

From $20^h\ 1^m$ to $20^h\ 6^m$ (Greenwich Civil Time) we registered on our radio-receiving set the rhythmic time-signals from the LY station (Bordeaux). We secured the whole series of tops—but at the same time the 'aurora statics' disturbed the pen of the registering instrument. The impulses thus registered are of varying strength, and each of them is of course exceptionally well determined in time, being 'received' at the same time as the scientific *time signals*. I therefore think that they may be of some interest. The maximum impulses of 'aurora statics' and their duration were:

No	Greenwich Civil Time.	Duration.
1	$20^h\ 4^m\ 28^s{\cdot}60$	$0^s{\cdot}08$
2	$20^h\ 4^m\ 29^s{\cdot}49$	$0^s{\cdot}10$
3	$20^h\ 4^m\ 39^s{\cdot}90$	$0^s{\cdot}25$
4	$20^h\ 4^m\ 40^s{\cdot}50$	$0^s{\cdot}25$

As regards the intensity of these impulses, I find that in each case the vertical component was greater than 100 microvolt/metre.

When, after the reception of the time signals, we again went out of the observatory, the curious sound had absolutely ceased, and later in the night, when also the aurora had vanished, we noticed that the atmosphere was as if swept clean from statics and disturbances of our wave-length.

Concerning the curious sound, I would only remark that the weather was absolutely calm when it was heard. As regards our antennæ system, it may be said that it consists of 5 strands of 40 metres each. Our receiver set is an aggregate, consisting of a three-circuits tuner, two high-frequency valves, one modulator, one heterodyne, four low-frequency valves, relay and chronograph.

HANS S. JELSTRUP,
Astronomer to the Norwegian
Geographical Survey.

Oslo (Norway), Dec. 1, 1926.

To the above most interesting communication from M. Jelstrup I may add the following:

On Oct. 15 I had the aurora stations at Bygdo, Oslo, Oscarsborg, Tomte, and Kongsberg in action from about 18^h Greenwich Civil Time to about 2^h on the following morning, and photographs were taken all the time from single stations, and from two or three stations simultaneously. About 70 successful photograms for the determination of height were secured.

Only a few of these have as yet been measured and calculated, and they show the ordinary heights of the aurora, from 90 kilometres to more than 400 kilometres. Fig. 1 shows one of the best photographs of curtains at $19^h\ 5^m\ 46^s$, taken from Oslo to the west. The simultaneous photograph from Oscarsborg proves that the lower border of the left curtain was from 124 to 131 kilometres above the earth, the middle curtain from 103 to 114 kilometres, and of the right from 110 to 132 kilometres.

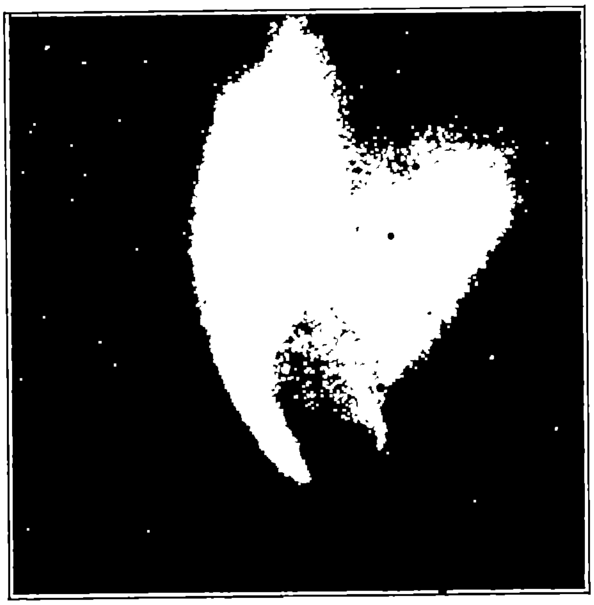

FIG. 1.—Aurora curtains photographed on Oct. 15.

During the period from $19^h\ 15^m$ to $19^h\ 25^m$ when M. Jelstrup heard the whistling of the aurora, I regret that no successful photograms were taken. From the visual observations made simultaneously at Bygdo by the meteorologist Rostad, who helped me during the work, I quote the following:

$19^h\ 10^m$. Dense masses of rays and curtains down to the horizon in E. and S.E.

$19^h\ 12^m$. The same down to the horizon in W., to the polar star in N., to the horizon in E., and down to 40° over the horizon in S.

$19^h\ 14^m$. The same to the Great Bear in N.

$19^h\ 16^m$. The same in the N. and S. down to 15° over the horizon. Red in S.

$19^h\ 21^m$. Strong diffuse arc through Can. venat. from the horizon in N.W. to the horizon in N.E.

$19^h\ 24^m$. Pulsating aurora begins.

$19^{h}\ 26^{m}$. Strong pulsations over the whole heavens. Red in S.

During the radio signals mentioned by M. Jelstrup the following observations are noted:

$20^{h}\ 3^{m}$. The pulsations have ended. All over the heavens a diffuse light. In the pocket spectroscope the yellow-green auroral line could be seen everywhere, from the entire heavens, from the snow, and from everything which was illuminated by the diffuse aurora.

$20^{h}\ 9^{m}$. Some pulsating bundles of rays.

$20^{h}\ 12^{m}$. The pulsations stronger and rays begin to appear.

It seems to me probable that the sound which, as M. Jelstrup says, exactly followed the vibrations of the aurora, could not come directly from the latter but from the surroundings, trees, antennæ, and so on, and were caused by electrostatic discharges, which in their turn were caused by influence from the varying electrostatic charges of the aurora overhead.

CARL STØRMER.

Bygdö, Oslo,
Norway.

Clerk Maxwell and the Cavendish Laboratory.

OF all the notable contributions to the record of the Cavendish jubilee given in the issue of Dec. 18, perhaps the most interesting to many is the one by Sir Joseph Larmor on Clerk Maxwell; for it suggests the way in which his equations, like those of the writer himself, contained the germs of many future developments, and incidentally directs attention to a Royal Society abstract which was unfortunately omitted from Maxwell's "Collected Papers." It was customary at that period for the Royal Society to publish not only the complete paper in the *Phil. Trans.*, but a thorough abstract also in the *Proceedings*—a practice which, perhaps unfortunately, has been departed from. The abstract referred to appeared in Dec. 1864, and gave in concise form the substance of one of the most remarkable memoirs of last century, "A Dynamical Theory of the Electromagnetic Field."

The abstract is exceptionally clear and luminous, and I should judge was written by Clerk Maxwell with some enthusiasm. It is, as Larmor says, full of ideas which have survived and developed since, though they have been supplemented and for a time apparently replaced by relativity and quantum considerations. It is possible, however, that posterity will see in Maxwell's ideas of more than half a century ago rather more than we perceive now; just as we now see in Faraday's "Thoughts on Ray Vibrations" more than seemed likely at the time. In order to make that Maxwell abstract more readily accessible to the present generation, and on the Continent, I suggest that it might be reproduced in NATURE.[1]

I venture to think that mathematical physicists are often too satisfied with incorporating their ideas in a compact form, not in its fullness readily intelligible, and refrain from elaborating their full significance after anything like the same fashion as men of letters elaborate and discuss and attend in detail to the great utterances of the past. The novelty of Clerk Maxwell's views at that period is sufficiently demonstrated by the reception or non-reception of them by Lord Kelvin and by the great physicists of the Continent. They were never altogether overlooked in Great Britain, but not until they were clinched by Hertz did they make their way in Europe; and the present generation is so occupied with its own rapid advances that a reminder of the ideas held by a pioneer long before most of them were born might be opportune and serviceable.

Incidentally, I would put on record a mention of what will doubtless elsewhere be referred to, namely, the remarkable gathering of physicists at Cambridge in celebration of Sir J. J. Thomson's seventieth birthday; a gathering which, though partly of a domestic character, was a sign of the enthusiasm and prolific genius of our own times, and could not have been surpassed in any city or university of the world. Indeed, if an earthquake or other catastrophe had overwhelmed the room in which that meeting was held, on the evening of Dec. 18, the science of physics would have taken long to recover from an irretrievable loss. The world at large, and even the disciples of other branches of science, do not realise to the full the magnitude of the developments which are now going on, both in actual achievement and in luminous speculation. We live in a time of upheaval, for the ultimate result of which we may have to wait many years; but there was in that gathering an element of hope, in the large group of younger workers, many present, others referred to, who show no sign of resting from their labours or being satisfied with the consolidation of past achievement, but are actively engaged in following up clues and in applying their well-prepared minds to future and perhaps still more fertile discoveries.

OLIVER LODGE.

Dec. 21.

The Mystery of Money.

I DO not think the writer of the very full review published in NATURE (Nov. 27) of my book, "Wealth, Virtual Wealth and Debt," really understands my new theory of money or the solution of the economic paradox, which he states, surely rather prematurely and prophetically, will be rejected by every student of economics. After all, I suppose every student of chemistry rejected the theory of atomic disintegration when it was first proposed a quarter of a century ago.

The reviewer quotes me to the effect that the aggregate of money, *irrespective of its quantity*, represents the aggregate value of the wealth which the community prefers to be owed rather than to own—which negative quantity of wealth I term the *Virtual Wealth* of the community—and then states that the argument is not lucid, even to the trained student, especially when he reads on a later page that the virtual wealth has in fact little to do with the quantity of money. He alleges I do not seem to realise that people retain money balances for their convenience, although on p. 205 I state, "It suits some of the people's convenience and affairs all of the time and all of the people's some of the time to be owed rather than to possess wealth so that they may be at liberty to select at their own time the sort and quantity they need . . . in exchange for their money." Similarly, with regard to my proposals to issue national money in lieu of bank credit, ending with: "In truth, Prof. Soddy's real plea is for the nationalisation of banking," the criticism is a travesty of what I do propose and the 'real plea' about the last thing I would advocate.

As regards the new theory of money, it follows the ordinary quantity theory, familiar to every trained student, in regarding the value or purchasing power of the unit of money as being inversely proportional to the quantity in circulation, considered as a single independent variable. This is the same thing as saying, as I do, that the value of all of it is the same, whatever that all may be. I should have rather expected from the trained student and the economist the criticism that my new theory was a mere round-about and unnecessary re-enunciation of the old quantity theory, though they are in fact quite different. On my theory the value of the aggregate quantity of money is a negative non-existent quantity of wealth, not amenable to the laws of conservation, and alterable, though not very widely, by purely psychological factors. On the quantity theory it is related, in some indefinite and unexplained way, with the quantity of goods in existence, and, by what will I think come to be regarded as a very curious blunder, also with the velocity of circulation of money, although changes in the velocity of circulation affect equally rates of production and consumption and leave the quantity of goods in existence unchanged.

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[1] We hope to be able to find space to reprint the abstract in an early issue.—ED. NATURE.

I can only deal in limited space with a few of the other criticisms. As regards the War inflation, I do not want "to put the clock back." The evils the country is now experiencing are the direct consequence of the attempt to put the clock back to pre-War as regards the value of money. I want for the future to stop all possibility of juggling with the value of the £ sterling as much as with that of the lb. avoirdupois. The reviewer states that my proposals would bring to the ground "the whole credit structure, with all the assistance it renders to industry." My object is absolutely to destroy the whole system of fictitious credit in which, not the lender, but the general public gives up what the borrower receives, paying the principal out of the purchasing power of the money they own, and the interest out of taxation, and to replace it by a system of genuine credit in which the lender gives up what the borrower receives. As for the "assistance" the existing system renders to industry, look around and meditate upon Cacus who dragged the oxen back into his den that it might appear he had let them out. Where else but in the so-called science of business would it be deemed unimportant who provided and gave up the money for a loan so long as it was provided?

The reviewer himself answers his own doubt as to how the £M2000 of new money to replace bank credit would be issued. "The new money would unquestionably be paid into the banks," who have "in future to keep pound for pound against" *current-account* "deposits." The money will continue to be, as it already is, in circulation by cheque. There is no addition to the quantity, but it is proposed to rectify the omission of the banks to pay the State for it when they issued it and put it into circulation. The 'penalisation' of holders of War Loan by the redemption of their stock is imaginary. The stock would be bought on the open market, and if they do not want to be 'penalised' they need not sell it.

I admit my proposals do not fully solve all the problems facing Great Britain in its excessive dependence on export trade for its food, and merely claim that they would make their solution easier rather than more difficult. The reviewer misrepresents me as advocating "floods of new currency . . . [being] issued by the State *pari passu* with the optimism of the producer" despite the absence of foreign buyers. Money is issued *pari passu* with increase of production to maintain the index number, or the *average* level of home prices, constant, and to keep them from falling with the increase of production. Goods unwanted and for which there are no buyers would fall in price, and the goods the buyers wanted would rise in price *relatively* as now. It is the average price-level which is maintained constant.

FREDERICK SODDY.

131 Banbury Road, Oxford.

IT is always unprofitable to both author and reviewer to attempt to reconcile conflicting views by further explanation on either side. Space alone precludes a successful issue. Such differences can only be left to the arbitrament of the reader. In this case he can clearly judge on the count of lucidity. A few further points may be within the limits of his patience.

Prof. Soddy's conception of "virtual wealth" is a phantasy. Every deposit in a bank is balanced by an asset, presumably of genuine value and backed by real goods or definite rights. These deposits constitute part of the aggregate quantity of money. The author contends in his letter that their value is a "negative non-existent quantity of wealth." Passing by the difficulties of determining how a quantity can be non-existent or how a value (connoting the abstract) can be a quantity (connoting the concrete), let the reader note that the review agreed (with the author) that the purchasing power created by bank loans is abstracted from the community, through the consequential reduction of the general purchasing power of money. Hence, if the borrower gains (temporarily and upon his undertaking ultimately to repay it to the bank) what the community loses, and if that loss is real—as Prof. Soddy truly argues—how can the gain, which is expressed quantitatively by the deposit created by the bank loan, be non-existent?

While accepting the author's statement that the nationalisation of banking is the last thing he would advocate, the reviewer still adheres to the opinion that it would be impracticable to give the State all the credit powers of the present banking system unless it also owned and conducted that system. The State is indeed contemplated (p. 198) as replacing the banks as a lender of £2,000,000,000.

Prof. Soddy urges that after the State has issued this amount of new currency, each bank when it lends in future is to give up what the borrower receives. We may start then with a simple balance sheet of:

STAGE 1.

Liabilities.		*Assets.*	
Capital . . .	£20	Cash	£120
A's Deposit . .	100		
	£120		£120

B, wishing to borrow £100, goes to the bank, which is to give up to him £100 cash. Let it do so. B spends the cash in buying, say, a house from C, and C deposits the cash in the bank. The balance sheet then appears:

STAGE 2.

Liabilities.		*Assets.*	
Capital . . .	£20	Cash	£120
A's Deposit . .	100	B's advance . .	100
C's Deposit . .	100		
	£220		£220

So the process goes on until the ratio of cash to deposits reaches the safe limit of 1 to x. How does this differ from the present system? Not one whit. But Prof. Soddy will retort that he has stipulated that the bank must keep pound for pound against deposits, so that stage 2 can never be reached. Exactly, and so the review stated that the banks can earn no interest, and that the whole credit structure would thereby be brought to the ground.

Lastly, does Prof. Soddy seriously consider that holdings of £2,000,000,000 of interest-bearing War Loan could be permanently cancelled by its purchase on the open market in exchange for 'new national money' issued by the State, such money bearing no interest at all? If so, he has yet much to learn of human nature. W. H. Coates.

[No further correspondence on this subject can be accepted.—Ed. Nature.]

Transmission of Excitation in Plants.

In his letter in Nature of October 23, Prof. N. G. Ball throws doubts upon the validity of my conclusions that in Mimosa (1) the transpiration-current has nothing to do with the conduction of the excitatory impulse, and (2) that the conduction is a phenomenon of propagation of protoplasmic excitation. I would refer Prof. Ball to my work "The Nervous Mechanism of Plants" (1926) for accounts of experimental demonstrations fully justifying the above conclusions. Limited space available allows me to refer here only to a few of the more important results.

The possibility of stimulating Mimosa by application of extracts of the stem to the basal end of a cut shoot has been adduced as evidence in support of the transpiration-current theory. This is by no means conclusive, as I have already pointed out in "The Nervous Mechanism of Plants," p. 17: "It is conceivable that certain vegetable extracts might act as stimulants; vegetable alkaloids of a poisonous nature, for example, produce excitation when applied in minute doses to the cut end of the stem. It would, however, be quite unreasonable to conclude from the result that an alkaloid is excreted from the plant under the action of a minimally effective stimulus." The following facts will be found to discredit the theory of transpiration-current.

1. The transpiration-current theory is based on the supposition that injury to wood caused by the wound, produces a stimulating substance which, being carried by the transpiration-current to the leaf, stimulates it to movement. It follows from this theory (*a*) that an intense wound-stimulus is essential for stimulation; (*b*) that the impulse should only travel upwards in the same direction as the ascent of sap; (*c*) that the velocity of the transpiration-current should be the same as that of the excitatory impulse; and (*d*) that in conditions where there can be no ascent of sap there should be no transmission of impulse.

I will take these points one by one. (*a*) I have shown that Mimosa can be excited by an electric shock one-tenth of the intensity of that which evokes human sensation. No wound is produced, yet the excitation produced by such an excessively feeble stimulus is transmitted to a considerable distance. (*b*) The excitation is found to be *simultaneously conducted both upwards and downwards*. It is also found that, under moderate unilateral stimulation, *the transmitted excitation ascends along one side of the stem to the apex and descends down the other*. The transpiration-current could not possibly have produced this result. (*c*) Accurate determinations of the velocities show that the rate of transmission of excitation is several hundred times quicker than that of the ascent of sap. (*d*) The tip of the uppermost leaf of Mimosa was stimulated by the application of a drop of hydrochloric acid: an impulse was generated which travelled to a considerable distance downwards against the direction of the normal ascent of sap. Subsequent chemical examination proved that the stimulant had not been transported, but had remained localised at the point of application.

These experimental results leave no doubt of the unfounded character of the transpiration-current theory. Nor can this theory be considered to have established its claim to acceptance until it has been demonstrated that excitation induced not by flame alone, but by stimulus of every kind—chemical, mechanical, electrical—is transmitted across the water-gap in the fundamental experiment upon which the theory has been built.

2. I next adduce positive evidence which proves that the transmission in the plant is one of protoplasmic excitation. This is demonstrated by the fact that the transmission is correspondingly modified by all conditions which modify the transmission of excitation in the animal nerve. The polar action of a constant electric current is identical in the two cases; when the current is feeble, stimulation occurs at cathode-make, the excitation being transmitted to a distance; with stronger current, excitation is produced at cathode-make and at anode-break. In both Mimosa and animal nerve, the velocity of transmission is increased within limits by a rise of temperature, and diminished by a fall. In both, transmission may be arrested temporarily or permanently by various physiological blocks. When the conducting tissue in the animal or plant is cooled, the speed of the impulse is slowed down, culminating in its arrest. The conducting power is temporarily arrested by a block produced by the passage of an electric current in a portion of the conducting tissue through which the impulse is being transmitted. This electrotonic block is removed on the stoppage of the current. Finally, poisonous solutions abolish the conducting power of both animal and plant.

These results offer conclusive proof that the conduction in the plant is a phenomenon of propagation of protoplasmic excitation, as in the nerve of the animal. J. C. Bose.

Bose Institute, Calcutta,
Nov. 17.

The Behaviour of Cultures of *Leishmania tropica*, *L. infantum*, and *L. braziliense* in the Sandfly, *Phlebotomus papatasii*.

Experiments were carried out to determine the behaviour of *Leishmania braziliense* and *L. infantum* in *P. papatasii*. The sandflies were infected by feeding through a membrane of rabbit skin on emulsions of flagellates in inactivated rabbit serum or defibrinated rabbit blood, and control experiments were performed with *L. tropica* in sandflies similarly infected.

L. tropica from cultures introduced into the sandfly *P. papatasii* (irrespective of the age and source of the strain of *L. tropica*) behaved exactly as *L. tropica* ingested by the sandfly from oriental sores, *i.e.* infection was always present in the uppermost end of the cardia, and in two cases out of twenty, flagellates were also found in the pharynx. Further, in cases of light infections the flagellates were confined to the uppermost part of the cardia only and, in some cases, sandflies which had fed on an emulsion of 100·000 flagellates per c.mm. were found to contain no flagellates at all. Passage of *L. tropica* from cultures through *P. papatasii* appears to increase the pathogenicity for man of the organism, as the following experiment shows.

A subculture made on August 27 from a culture taken directly on July 7 from an experimental human lesion was used for the experiment. September 15, Sandfly No. 172 (hatched in laboratory, September 15) *P. papatasii* ♀ fed on emulsion of culture (100·000 per c.mm.) September 26: Sandfly died and was dissected. Numerous flagellates were found in the midgut, particularly in the uppermost part of the cardia, which was almost completely choked up by flagellates. The majority of the flagellates were long free forms. The stomach of the sandfly was inoculated into a scarified point on the right forearm of a volunteer. At the same time, flagellates from the same culture on which the sandfly fed were inoculated into two scarified points on the left forearm of the same volunteer.

Result—November 1: Leishman-Donovan bodies were found in a papule on the right forearm on the site of the inoculation with material from the sandfly.

Nothing has so far (November 16) been observed on the sites inoculated with flagellates from culture.

Leishmania infantum and *L. brasiliense* ingested by sandflies (*P. papatasii*) from emulsions of flagellates behaved quite differently from *L. tropica*. Although active division and, in the case of *L. brasiliense*, marked morphological changes occurred in the sandfly (development of short stumpy forms into long and thin forms and exflagellation of Leishman-Donovan bodies), the flagellates were confined to the stomach, and, in two cases out of twenty in *L. brasiliense*, flagellates were also found in the lowest part of the cardia. In no case were the flagellates found in the uppermost part of the cardia in the neighbourhood of the œsophageal valve, nor were any forms found attached to the epithelium.

The researches of the Indian Kala-azar Commission on the development of *Leishmania donovani* in *Phlebotomus argentipes* and our own observations on the development of *L. tropica* in *P. papatasii* tend to show that the sandfly in which flagellates of a species of Leishmania are found attached to the epithelium and free in the uppermost part of the cardia is the carrier of that species of Leishmania, *e.g. P. papatasii* is a carrier of *L. tropica* and *P. argentipes* is a carrier of *L. donovani*.

Should the above observations be repeated with recently isolated strains of *L. infantum* (infantile leishmaniasis is absent from Palestine) there would be very strong evidence to the effect that *P. papatasii* is not the carrier of *L. infantum*, and the carrier of this parasite is to be sought in *P. perniciosus*, *P. sergenti*, or a member of the *minutus* group of the genus Phlebotomus. The fact that cultures of *L. tropica* behave exactly as ingested Leishman-Donovan bodies in *P. papatasii* is important, for it suggests that the simple and rapid process of observing the behaviour of cultures of a given species of Leishmania in sandflies may be used for determining which Phlebotomus sp. is the transmitter of that particular species of Leishmania.

S. Adler.
O. Theodor.

Microbiological Institute,
Hebrew University,
Jerusalem, Nov. 16.

The Origin of Fatuoids in Cultivated Oats.

The sudden appearance of fatuoids, that is, forms resembling the wild oat *Avena fatua*, in varieties of the cultivated oat *A. sativa*, has for many years attracted much attention both by its genetic interest and agricultural importance. The opinion has been widely held that they originate through natural crossing between *A. sativa* and *A. fatua*, but in recent years they have been more generally regarded as simple loss mutations from *A. sativa*. The heterozygous form, which is intermediate between the normal and the fully developed fatuoid, usually appears first, and in nearly all cases previously recorded these heterozygotes segregate normals, heterozygotes, and fatuoids in a ratio of approximately 1 : 2 : 1.

A combined genetical and cytological study of this problem, begun early in 1924, has revealed many new and interesting features. Not only have three, or possibly four, different types of heterozygous fatuoids been discovered, thus bringing the problem closely into line with the speltoid problem of cultivated wheat, but distinctive chromosome conditions have also been found to be correlated with the genetic behaviour and with the character of the segregates in the different types. The first and most common type, giving the 1 : 2 : 1 ratio of normals, heterozygotes, and fatuoids, has been described in Nature, 115, 677-678, 1925, and *Scientific Agriculture*, 6, 303-313, 1926. Briefly, all the segregates are of approximately equal vigour, and all have the normal number of chromosomes, namely, forty-two; but while in the normals these form twenty-one bivalents, in the heterozygotes the arrangement is frequently nineteen bivalents, one trivalent, and one univalent, and in the fatuoids it is often nineteen bivalents and one quadrivalent.

The second type also gives a ratio of approximately 1 : 2 : 1, though the numbers so far obtained are too small to determine this exactly, but the fatuoid segregates from it are all dwarfed and partially sterile. In this case the normal segregates again have twenty-one bivalent chromosomes. The heterozygotes, however, have an extra chromosome, and their complement is either twenty-one bivalents and one univalent, or twenty bivalents and one trivalent. The dwarf fatuoids in this type have two extra chromosomes, the total of forty-four being arranged usually as twenty bivalents and one quadrivalent.

Normals and heterozygotes are segregated in approximately equal numbers by heterozygous fatuoids of the third type. The fully developed fatuoid form appears only very rarely, and is always dwarf and sterile. The normal segregates, again, have the normal twenty-one bivalents. The heterozygotes, however, have lost one chromosome and have only nineteen bivalents and one univalent. The sterile dwarf fatuoids have completely irregular meiotic divisions, including faulty pairing, and their total chromosome number is only forty.

The fourth type has arisen from the third, and is similar to it except that the heterozygous segregates are much more numerous than the normals, the ratio being about 5 : 1. In four heterozygous plants of this type which have been cytologically studied, the chromosome number is forty-one, as in heterozygotes of the third type. Certain differences in the chromosome behaviour, such as the more frequent formation of trivalents and the lagging of one or two bivalents, have been observed, but until the genetical constitution of the particular plants has been determined, it is impossible to say whether these minor differences have any special significance.

The close correlation between cytological conditions and genetic behaviour in these different types of fatuoids seems to indicate clearly that fatuoids arise from normal oats, not by either gene mutation or natural crossing, but by any one of several different chromosomal irregularities, which upset the normal chromosome balance and permit the expression of other characters.

Discussion of the particular hypotheses which best fits the observations must be left for the full account of this work, which will shortly be prepared.

On the practical agricultural side there has emerged the possibility of developing commercially valuable varieties of oats which are entirely free from fatuoid factors.

C. Leonard Huskins.

Department of Botany,
King's College, London, W.C.2,
Dec. 8.

X-ray Evidence for the Existence of Different Modifications of Fatty Acids.

In continuation of the work on the high order X-ray reflections of fatty acids done in this laboratory (J. A. Prins and D. Coster, Nature, July 17, 1926), I tried to get the high orders with stearic acid. In determining the long spacing of a crystal of stearic acid obtained by slow crystallisation from acetone, I found the remarkable fact that the crystal showed a long spacing of 43·95 A.U., whereas a thin layer obtained by melting the acid on a glass strip gave a spacing of 39·75 A.U. Crystals obtained from alcohol and petrol also showed the larger-spacing. A film obtained by evaporating an alcoholic solution on a glass strip gave the smaller spacing, but an acetonic film gave the two spacings, the relative intensities of which were altered by slight changes in the way of forming the film. Apparently these facts point at the existence of different modifications of stearic acid.[1]

As, on the other hand, Garner, Randall and Ryder (*Jour. Chem. Soc.*, 125, 881, 1924; 127, 720, 1925), from a determination of the heat of crystallisation and molecular volume, concluded that undecoic acid exists in two enantiotropic modifications, it seemed worth while to test this point by an X-ray investigation. According to Garner (*loc. cit.*) the transition takes place between 12·5° C. and 17° C. I determined, therefore, the long spacing of a layer of undecoic acid obtained by melting on a glass strip, first at 20° C. and a second time at 12·5° C. the apparatus not being changed between the two exposures (the lower temperature was obtained simply by opening the windows). At the higher temperature a spacing of 25·4 A.U. was found, which spacing has already been measured by Müller and Shearer (*Jour. Chem. Soc.*, 123, 3156, 1923). At the lower temperature, however, these lines had practically disappeared and another set of lines of strong intensity occurred on the plate, these lines belonging to a spacing of 30·1 A.U. When the temperature was raised again to 20° C. and a photograph was taken after some hours, the lines due to the longer spacing, though not wholly disappeared, were much fainter, whereas the intensity of the lines belonging to the smaller spacing had much increased. These facts give a strong support to the view suggested by Garner and his collaborators.

After these results were obtained the beautiful work of Piper, Malkin and Austin (*Jour. Chem. Soc.*, Sept. 1926) on the different modifications of the even fatty acids came to my notice. As is stated by these authors, the different spacings of stearic acid seem to be independent of the temperature, and only to depend on the manner the reflecting layer is obtained.

The higher orders are now being investigated in order to get some information about the molecular structure of the different modifications.

I am much indebted to the kindness of Prof. P. E. Verkade of Rotterdam, who put a quantity of very pure undecoic acid at my disposal.

G. M. de Boer.

Physical Laboratory of the University,
Groningen, Holland.

A Rock of Unknown Origin from Glacial Gravel at Ipswich.

A little time ago I found, in the sub-Chalky Boulder Clay glacial gravel, exposed in the brickfield of Messrs. A. Bolton and Co., Ltd., to the north of Ipswich, an erratic of unusual and arresting appearance. The gravel in which the specimen was embedded is that which, in my opinion, was laid down in the interval of time between the deposition of the Kimmeridgian Chalky Boulder Clay and that of the Upper Chalky Boulder Clay of East Anglia. As I had never before seen a rock in the Ipswich area of the type discovered, I submitted it to Prof. P. G. H. Boswell, of the University of Liverpool, and to Dr. Herbert H. Thomas, of the Geological Survey, for investigation. Both these experts, though giving me valuable information upon the nature of the erratic, were unable to inform me as to its probable source of origin, and Dr. Thomas, suggesting that this source might be in some area of old rocks, such as Scandinavia, advised me to submit the specimen to Prof. Victor Goldschmidt, of Oslo. This I have now done, and with Prof. Goldschmidt's permission, I give below the result of his examination of the rock.

"I have got your specimen, and I have examined it. If the boulder has its place of origin in Norway, it must be a sandstone from one of the pre-Cambrian formations. The rock is a breccia, consisting of fragments of a sandstone rock in a matrix. The sandstone of the fragments is without any doubt a sedimentary rock, containing well-rounded grains of quartz. The matrix is rather fine-grained; the matrix contains perhaps even pyroclastic material, but that could not be ascertained. The clastic grains of the matrix are angular. One may say that none of the Eocambrian, Cambrian, or other Palæozoic sandstones of Norway has any resemblance to your specimen. Among the pre-Cambrian formations there might be several possibilities for placing the boulder. It is most likely that it may be derived from the pre-Cambrian Telemark formation, which, among other rocks also includes quartzitic sandstones, breccias, and also pyroclastics. The general character of the rock, its degree of re-crystallisation, makes it possible, but of course not certain, that it is derived from the districts around the mountain Gausta in Telemarken. My friend, Prof. J. Schetelig, to whom I showed your boulder, also agrees with me. But neither of us has ever seen exactly the same rock *in situ*. We shall look for it in Telemarken. I shall send the boulder back to your address by mail to-morrow. The thin section I shall keep here, to have a possibility to identify the boulder, if I succeed in finding the breccia *in situ*."

I would wish to thank Profs. Boswell and Goldschmidt, and Dr. Thomas, for the help they have given me in this matter. The rock, which I have deposited in the Ipswich Museum, where it can be examined, is of a definite pinkish colour.

J. Reid Moir.

One House, Ipswich.

Thermal Agitation of Electricity in Conductors.

Ordinary electric conductors are sources of spontaneous fluctuations of voltage which can be measured with sufficiently sensitive instruments. This property of conductors appears to be the result of thermal agitation of the electric charges in the material of the conductor.

The effect has been observed and measured for various conductors, in the form of resistance units, by means of a vacuum tube amplifier terminated in a thermocouple. It manifests itself as a part of the phenomenon which is commonly called 'tube noise.' The part of the effect originating in the resistance gives rise to a mean square voltage fluctuation V^2 which is proportional to the value R of that resistance. The ratio V^2/R is independent of the nature or shape of the conductor, being the same for resistances of metal wire, graphite, thin metallic films, films of drawing ink, and strong or weak electrolytes. It does, however, depend on temperature and is proportional to the absolute temperature of the resistance. This dependence on temperature demonstrates that the component of the noise which is proportional to R comes from the conductor and not from the vacuum tube.

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[1] Both lattice-constants have already been measured by Muller (*Jour. Chem. Soc.*, 123, 2043, 1923; Nature, 116, 45, 1925), but he seems not to have paid much attention to the discrepancy between these two results.

A similar phenomenon appears to have been observed and correctly interpreted in connexion with a *current sensitive* instrument, the string galvanometer (W. Einthoven, W. F. Einthoven, W. van der Horst, and H. Hirschfeld, *Physica*, 5, 358-360, No. 11/12, 1925). What is being measured in these cases is the effect upon the measuring device of continual shock excitation resulting from the random interchange of thermal energy and energy of electric potential or current in the conductor. Since the effect is the same for different conductors, it is evidently not dependent on the specific mechanism of conduction.

The amount and character of the observed noise depend upon the frequency-characteristic of the amplifier, as would be expected from experience with the small-shot effect. The apparent input power originating in the resistance is of the order 10^{-18} watt at room temperature. The corresponding output power is proportional to the area under the graph of *power amplification—frequency*, at least in the range of audio frequencies. The magnitude of the 'initial noise,' when the quietest tubes are used without input resistance, is about the same as that produced by a resistance of 5000 ohms at room temperature in the input circuit. For the technique of amplification, therefore, the effect means that the limit to the smallness of voltage which can be usefully amplified is often set not by the vacuum tube, but by the very matter of which electrical circuits are built.

J. B. JOHNSON.

Bell Telephone Laboratories, Inc.,
New York, N.Y., Nov. 17.

Oxygen = 17. Oϕ.

I KNOW that I am very ignorant, but old and unrepentant as I am I still live to learn from young people and watch their doings with delight, tho' maybe they are sometimes a little 'previous.' The argument behind Messrs. Harkins and Shadduck's letter (NATURE, December 18, p. 875) is doubtless irreproachable and unanswerable. Probably, therefore, I am more than stupid in being surprised at "the atom (presumably oxygen of mass 17) which is synthesised." Suppose, however, that a poor errant molecule of fair hydrone were the stricken 'atom,' it might well be 'electrolysed' and give OH = 17 + H = 1. Who will say me nay and make it clear that this cannot be? Uesanian orders are sometimes tall and the propinquity of the Wheat Pit may well have influenced the Chicago laboratory, just as Cambridge, being an apanage of Newmarket, is given over to racing competitions and so demoralises the whole of our educational system.

I know full well, that it is wrong for a poor worm of a chemist to turn and put a common or garden interpretation upon the work of august and fashionable physicists: that they should be regarded as kings who can do no wrong. I have, however, preserved from my youth the memory of a king who wore no clothes and myself still work a little in the garden with not too much regard for weather. NATURE, too, disturbs my belief in things. In it, Dr. Jeans—who, being senior secretary of the Royal Society, a mathematician and a man who sees stars, must know everything—has recently assured us that the elements short of uranium are infinitely stable, even at the super-satanic temperature of 12,500,000 million degrees. If so, is a mere missile of mass 4 with a range of 6 cm. likely to knock spots off them? Cannot we rather picture the nitrogen molecule, in itself a hard nut to crack, as contemptuously asking, whenever hit by an α-particle: 'Who are you shoving of?' and moving on its way, naked and unashamed, uncaressed by the particle—this latter, attended as it is from its birth by the faithful electron, as then wickedly compassing the prostitution of fair hydrone?

My faith in the immaculate judgment of the 'Physicals' would be greater if they would curb their imagination by learning just a little chemistry and would seek to tell me what happens when I rub my stylo upon my coat sleeve: a fundamental question to which I can get no answer. The α-particle may be doing as the moving stylo does. When I read the heroics in NATURE of December 18, I am only too conscious of the greatness of the 'Electronicals': still, men with the unlimited speculative power they possess might sometimes deign to deal with matters which affect ordinary mortals and with the common objects of the laboratory floor.

HENRY E. ARMSTRONG.

Temperature Coefficient of γ-Ray Absorption.

RECENT improvements in design and technique for a gold-leaf electrometer, details of which will be published shortly, have made it possible to apply the instrument with success to the problem of a possible temperature coefficient of γ-ray absorption. Preliminary measurements with lead as absorber, over a temperature range of about 250° C., indicate that when due allowance has been made for the expansion of the lead, there occurs an increase in the absorption coefficient of approximately 0·2 per cent. per hundred degrees rise of temperature. That the effect is dependent on temperature, or indeed on any incidental at all, is somewhat of a surprise; and considerable interest is added by the recent account by H. S. Read (*Phys. Rev.*, 27, p. 373, 1926) of an effect of temperature on X-ray absorption, in which he records, for lead and the five other metals examined, a temperature increase in the coefficient of the same magnitude as here reported. Further investigation is contemplated.

L. BASTINGS.

The University, Durham,
Dec. 3.

The Supposed Law of Flame Speeds.

WITH reference to Prof. Bone's letter in NATURE of Dec. 11, p. 837, it is evident that the speed generalisation advanced by Prof. R. V. Wheeler and Dr. W. Payman must break down when one of the combustible gases in a complex mixture interferes with the burning of another. This has been shown to occur for carbon monoxide–hydrogen–air mixtures by Dr. Payman (*J.C.S.*, 115, 1454, 1919). In this case the speed of burning of carbon monoxide is much increased in the presence of hydrogen. The reverse effect occurs when mixtures of carbon disulphide not too far removed from the limit are mixed with certain other combustibles (*J.C.S.*, 121, 2561, 1922). By mixing suitable carbon disulphide–air and (say) ether–air mixtures having the same speed of flame, mixtures can be obtained which refuse to propagate flame.

A. G. WHITE.

45 Caledonia Road,
Saltcoats, Dec. 20.

Popular Long-Range Weather Forecasts.

SINCE last April, forecasts of the weather for fifty days ahead have been appearing in the *Daily Mail*. The forecasts, which are prepared by Lord Dunboyne, have excited a considerable amount of interest. The question of long-range forecasts has been engaging the attention of meteorologists for some time, and they would welcome any progress in this direction, even if in the first instance the forecasts were purely empirical. Lord Dunboyne has not published any account of the principles he uses, and it is not possible therefore to study the methods of the forecasts, but only the results obtained. The forecasts are given in the form of a diagram, and it is stated in the explanation that the higher the curve rises above a datum line the greater the probability of rain, and the lower the curve falls the greater the probability of dry weather. When the curve rises sufficiently far above the datum line, and rainy weather is indicated, the area within the curve is blackened, and similarly the lower parts of the diagram are shaded to indicate that dry weather is forecast.[1] In this way the periods when wet or dry weather is expected are shown at a glance.

From the curves it is possible to read off what are here called 'forecast numbers.' The day when the curve is below the datum line has a forecast number of 1; one with a curve on the datum line a forecast number of 2; a little above gives 3; considerably above the datum line but not up to a blackened area, 4, and when the curve rises to the blackened area the forecast number is 5. To compare the forecasts with the actual weather, readings have been taken from the *Daily Weather Report* from which weather numbers have been deduced. The weather number for each day is determined as follows: 5 is a day when more than 2 mm. of rain has occurred; 4 when the rainfall is between 0·2 mm. and 2 mm.; the other numbers are for days when the rainfall is less than 0·2 mm.; 3 is a day when the mean cloud amount is 8 or more; 2 when the mean cloud is between 3 and 7·9, and 1 when the mean cloud is 0 to 2·9. These cloud amounts are the means of the cloud amounts recorded at 9 A.M., 1 P.M., and 6 P.M. This seems to be a fair way of comparing the two sets of numbers. The only doubtful case is that of weather number 3, which represents overcast skies, for anticyclonic cloud may cover the sky in perfectly dry weather, and it would be unfair to class a forecast number of 1 as a failure, when the weather that occurred was anticyclonic, merely because the sky was overcast. But such weather, though it occurs in the winter, is not much in evidence in the summer, and the period under consideration is that from April to October; during this part of the year an overcast sky may very fairly be taken as half-way between rainy and dry weather, and the above criticism would not apply.

The diagrams are given for fifty days ahead, but they are amended from time to time, and therefore the forecast for a given week made six weeks ahead may differ from the forecast for the same week as given five, four, or less weeks ahead. To take, for example, the forecast for south-east England for the week commencing July 4 (Fig. 1). When this first appears in the *Daily Mail* for May 28 it shows the curve below the datum line for all the days except July 5 and 10, on which days the curve rises just above the datum line; that is to say, the forecast was for a week with a definite but small probability of fine weather. The next forecast for the same week shows the curve above the datum line for all days with a probability of rain on July 5 and 7; this probability seems to be reduced in the next diagram, and when we come to the forecast for three weeks ahead the curve has fallen below the datum line again except at the end of the week, when it rises a little above; for two weeks ahead a blackened area occurs on the last day, and the forecast for one week ahead is very similar. The actual weather experienced at Kew was as follows:

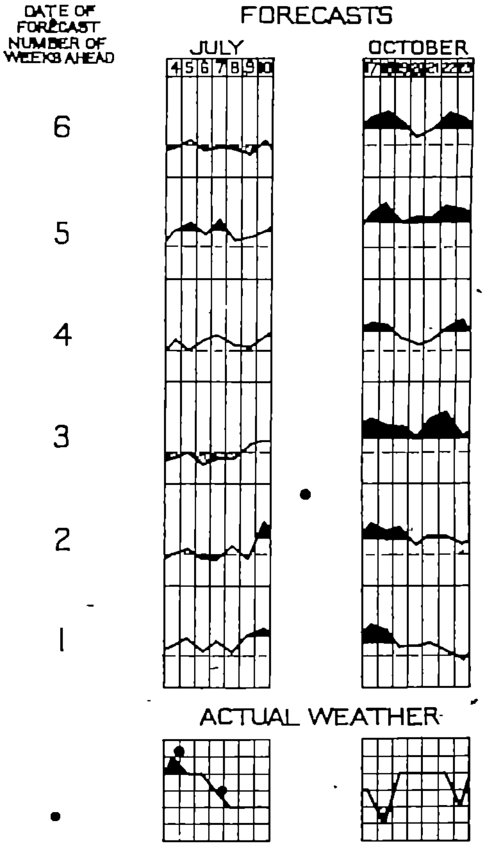

FIG. 1.

Date.	Rainfall.	Weather Number.
July 4 . .	5·0	5
,, 5 . .	2·0	4
,, 6 . .	0·6	4
,, 7 . .	Trace	3
,, 8 . .	..	2
,, 9 . .	Trace	2
,, 10 . .	Trace	2

Another week, that commencing October 17 (Fig. 1), when it first appeared in the *Daily Mail* for September 10, gave rain as probable at the beginning and end of the week, on all days, in fact, except September 20 and 21, but the curve was above the datum line for the whole week; the next curve was above the blackened area all the week. The forecast for four weeks ahead was very similar to the first one, but the blackened areas were reduced. The forecast for three weeks ahead had the curve again above the blackened area all the week. The next two charts kept the blackened area at the beginning of the week, but the curve fell lower at the end of the week, and in the last forecast of the series it was below the datum line on the last day of the week. The following was the actual weather at Kew:

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[1] Some slight changes have lately been made in the diagrams, but this does not affect what follows.

Date		Rainfall.	Weather Number.
Oct. 17	. .	..	3
,, 18	. .	Trace	1
,, 19	. .	0·3	4
,, 20	. .	0·3	4
,, 21	. .	1·0	4
,, 22	. .	1·1	4
,, 23	. .	0·1	2

These weeks were taken at random, without first looking up the actual weather that occurred, and without trying to find a case where successive forecasts differed among themselves. There are other examples where still more striking changes occurred in successive forecasts for the same week, changes much greater than would be expected from the statement that "the curves are subject to slight amendment as time advances." So little concordant with each other are the successive forecasts for the same week that it is evident that, whatever value the forecasts may have, six weeks is considerably too long a period for the methods employed.

In order to compare the forecasts with the actual weather, diagrams have been made from the weather numbers for Kew and Scilly, and have been placed below the forecast diagrams for south-east England and for south-west England respectively (Figs. 2 and 3). This method of comparing the forecasts with the weather experienced was used by Dr. W. J. S. Lockyer in a short communication sent a few months ago to the editor of NATURE, who later invited me to prepare the present article. Only the forecasts for one week ahead have been made use of.[2] An examination of these two sets of curves shows that the forecasts, though agreeing with the actual weather at times, yet on the whole show no relationship with the weather experienced. No shifting of the curves backwards or forwards in time makes any approach to a fit between the two except in a few isolated cases. The best fit is probably that for Scilly in August, but even in this case it must be remembered that if the forecasts had been chosen for more than one week ahead the curves would not have been the same as those actually shown. On the whole, there is no such general agreement between the curves of forecast and those of actual weather as would be expected if the forecasts had any sound meteorological basis.

Another way of looking at the results is to take the differences between the forecast numbers and the weather numbers; 0 would mean that the forecast was entirely successful, and 4 that it was as unsuccessful as possible. Taking the forecasts for south-east England for one week ahead and comparing them with the weather numbers for Kew, we find that there were 30 cases with a difference of 0, 72 of 1, 45 of 2, 21 of 3, and 16 of 4. Taking 0 and 1 together we get 102 complete and partial successes as against 82 that were not

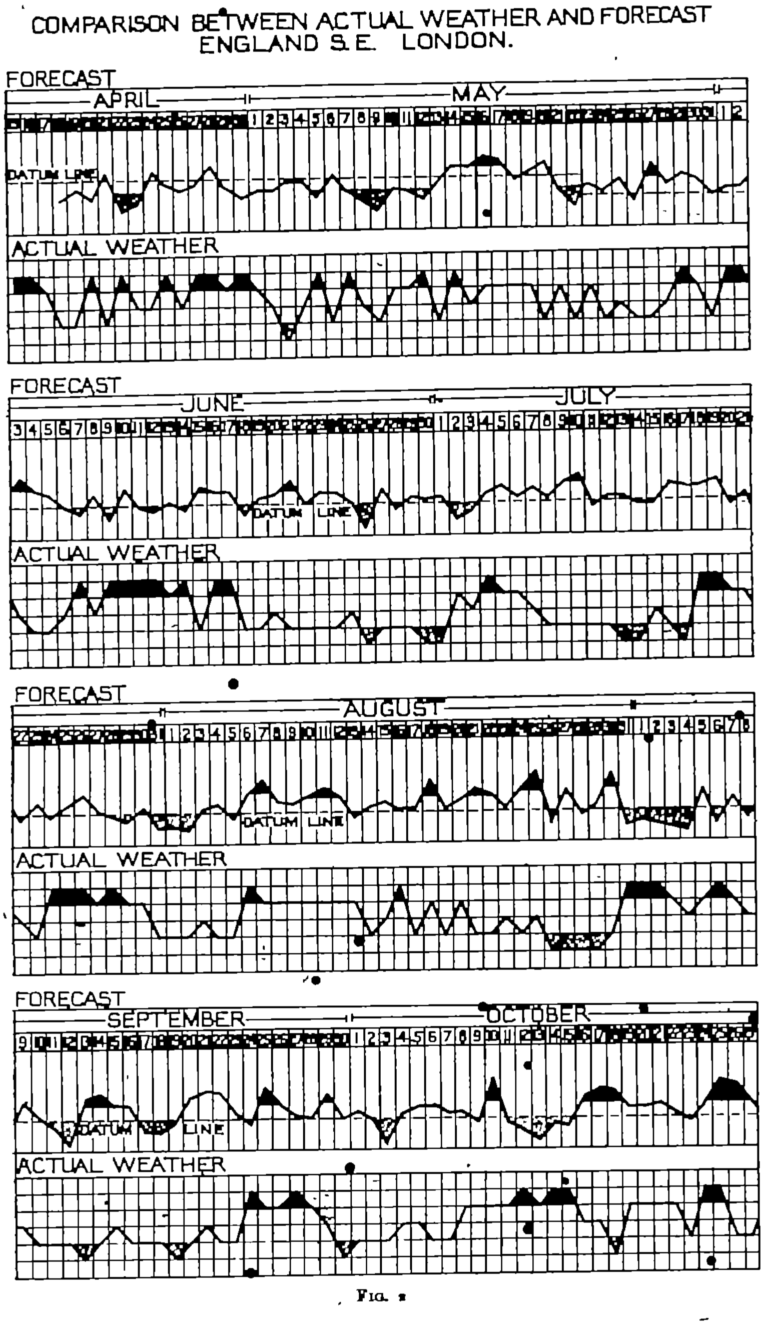

Fig. 2

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[2] As no charts were issued between April 30 and May 21 the forecasts which should have been for one week ahead for the period May 2 to May 22 were taken from the chart issued on April 30. Similarly, where forecasts for six weeks ahead for the period June 13 to July 3 are under consideration they are taken from the chart issued on May 21.

		One Week. 0	1	2	3	4	Six Weeks. 0	1	2	3	4
Kew.	Actual . .	30	72	45	21	16	30	57	29	28	9
	Chance . .	35	65	44	28	12	31	52	36	26	8
	Ratio . .	0·9	1·1	1·0	0·8	1·3	1·0	1·1	0·8	1·1	1·1
Scilly.	Actual . .	34	67	43	31	9	30	55	34	24	10
	Chance . .	35	62	40	33	14	31	50	33	29	10
	Ratio . .	1·0	1·1	1·1	0·9	0·6	1·0	1·1	1·0	0·8	1·0

a success. This means that the forecasts were successful in 55 per cent. of the cases and failed in 45 per cent. The results for Kew for six weeks, and the results for Scilly both for one week and for six weeks ahead, come out at almost exactly the same percentage. At first sight this seems a definite measure of success for the forecasts, but a further examination of the figures shows that this seeming success is illusory, since the figures are very near to those which would be expected on pure chance. The above table gives the difference between the forecast numbers and the weather numbers for Kew and Scilly both for the forecasts one week and six weeks ahead, together with the numbers which should be expected on pure chance, and with the ratio between them.

From this table it will be seen that the distribution is very close indeed to that of pure chance. If the forecasts had any measure of real success the table should show a high ratio for differences of 0 and 1, and low values for differences of 3 and 4; but there is no indication of this.

To emphasise the fact that the distribution is solely due to chance, the weather numbers have been taken for Kew and have been compared with the forecast numbers for different months, May with October, June with September, July with August, and so on; moreover, the days have been reversed, that is, the first is compared with the last day of the month, the second with the last day but one, and so on; therefore by no possibility can the weather numbers have any connexion with the forecast numbers; the differences come out as follows:—

0	1	2	3	4
35	70	45	27	7

This is in striking agreement with the legitimate comparisons, and emphasises the fact that the latter too have the appearance of being governed by nothing but chance.

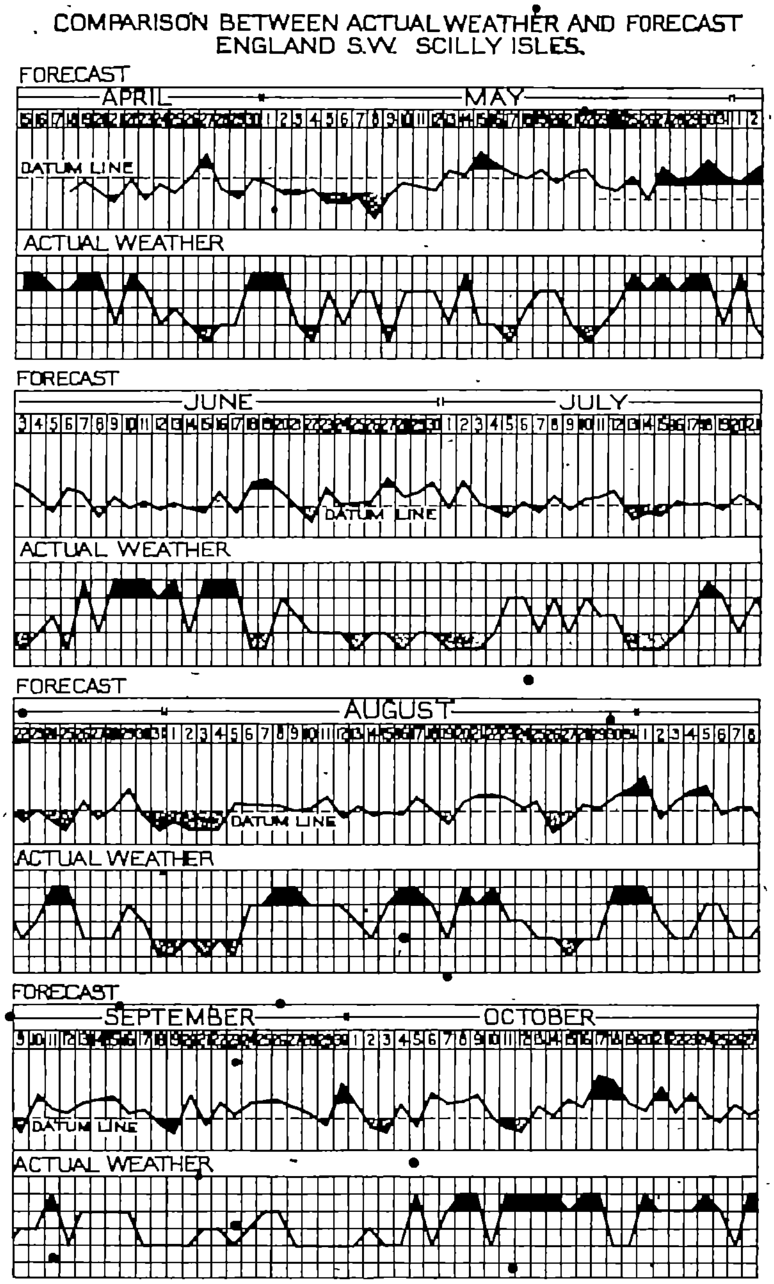

Fig. 3.

Yet another method of examining the figures is to take correlation coefficients between the forecast numbers and the weather numbers. The adjacent table gives these for each month for Kew and Scilly, and for forecasts of one week and six weeks ahead.

	Kew		Scilly.	
	One Week.	Six Weeks	One Week.	Six Weeks.
May . .	0	. .	0	. .
June . .	−0·2	−0·4	−0·3	−0·3
July . .	−0·1	−0·1	+0·1	+0·2
Aug. . .	+0·3	+0·1	+0·6	+0·4
Sept. . .	−0·2	−0·[illegible]	+0·4	+0·2
Oct. . .	−0·3	0	−0·1	−0·1

These coefficients have of course no significance; even the value of +0·6 for August in Scilly, standing alone, does not indicate any real relationship between the two sets of numbers.

It would appear, therefore, from the foregoing considerations that the forecasts, even for one week ahead, have not any success. They are not, in fact, any better than could be obtained by purely fortuitous predictions, and they agree with what one would expect from chance in a very marked way. Nevertheless, it would be interesting to have some account of the methods used. Lord Dunboyne has made a study of meteorology for many years, and if he were to propound a theory of forecasting it would meet with due consideration from meteorologists.

C. J. P. CAVE.

Regions of Compression.[1]

By Dr. J. W. EVANS, F.R.S.

II.

THE accumulation of great masses of sediment destroys for the time being the isostatic balance of the earth's crust, which is restored by the outward flow of the plastic sima beneath them to other areas where the amount of deposits is less, or towards mountains subjected to erosion that diminishes the superincumbent load.

As a result of this outflow the surface on which these thick deposits have accumulated is correspondingly lowered. Such a depression of a previously approximately level floor of deposition may be described as a *sedimentation subsidence*.

Thus thick accumulations tend, by the direct result of their weight, to form and fill hollows in the earth's crust, and so provide for their own preservation. Hence it is that, as the late G. W. Lamplugh pointed out, the areas in which geological formations have now their most important outcrops are those in which they were originally deposited in the greatest thickness.

Where such a sedimentation subsidence has occurred, we must distinguish two constituent parts of the resulting structure: the basal or *external* portion, consisting of the older and more consolidated rocks that formed the original floor of the area of deposition, and the *internal* deposits made up of the sediments and other materials accumulated upon the former.

The depth of the accumulated sediments, and consequently the amount of the subsidence, is greater near the foot of the mountain slopes, and gradually diminishes as the distance from the mountains increased, although at equal distances it will be thicker opposite the outflow of important rivers and less where these were absent.

At a greater distance from the region or regions of erosion, where the amount of sediment deposited was less, the accumulation of calcareous material from the growth of organisms or the precipitation of carbonate of calcium, also derived originally in the main from organic sources, must often have played a similar part in causing subsidence by their weight.

The eruption of lava and ashes will have a like result, intensified by the removal of the material from beneath. The general tendency would, however, be for the load and depression to diminish as the distance from the source increased. At the same time, the inflow of the plastic material from the area of maximum sedimentation would add to the effect of the decrease of the load. Ultimately, at a greater distance, where the deposition was still more reduced, elevation would replace depression.

In the period of comparative quiescence that intervenes between paroxysms of earth movements, resulting in folding and thrusting, the horizontal compressive forces in the earth's crust, which had (for the time being) been exhausted, are once more slowly developing and increasing in strength. At last the crust yields to the pressure where the resistance is weakest. Other things being equal, this will be where the solid crust is bent most deeply down in a sedimentation subsidence. There it is no longer flat and horizontal, and directly opposed to the forces of compression. It has consequently very much diminished powers of resistance, precisely as a pillar bent out of the vertical line is incapable of sustaining the same weight as if it were straight and erect. The weakness of the crust in the subsided area is increased by the fact that the depression of the solid floor through some thousands of feet brings the rocks into regions of higher temperature, and the increase in temperature must be accompanied by a considerable decrease in strength, while the unconsolidated deposits of the interior of the subsidence can add little or nothing to its powers of resistance.

Accordingly, it is in a tract of subsidence that the crust gives way under the forces of compression. It is true that these forces operate on the whole surface of the globe, but immediately the portion with least resisting strength yields, however slightly, the remainder of the great circle on which the yielding takes place is released *pro tanto*, adjusting itself by a movement of elastic expansion, so slow that the resistance opposed to it by the viscosity of the subjacent plastic sima is inappreciable.

It must be remembered, however, that, as already indicated, there are other horizontal forces affecting the earth's crust that may increase or diminish the forces of compression locally, and these may in some instances determine whether the crust yields at one subsided tract or another. When such a yielding has taken place, the probability of the crust giving way at another point is at once greatly diminished, at any rate for the time being.

The first effective action of such compressive forces usually antedates by a considerable period the epoch of maximum disturbance, and is as a rule very gradual and gentle, so that it merely narrows slightly and deepens the area of subsidence. The deposition of great thicknesses of a succession of shallow-water strata is usually explained as due to subsidence by way of isostatic adjustment of the earth's crust, to correct the disturbance of equilibrium from the weight of the sediments accumulated. Prof. A. Morley Davies has, however, directed attention to the fact that there is a limit to such an adjustment, because the density of the sediments laid down is less than that of the plastic subcrustal sima displaced.

Let s be the original depth of the sea, and l the amount by which the sea-bottom is lowered; then $s+l$ will be the thickness of the deposits if they reach the surface of the sea. Let the density of these sediments be ρ_a, that of the plastic sima displaced ρ_b, and that of sea-water ρ_s. Then, if isostatic conditions prevail both before and after the sedimentation, we shall have $\rho_s s+\rho_b l=\rho_a(s+l)$: that is to say, the weight of the sea-water over a unit of area before the deposition of the sediments, *plus* the weight of the sima displaced by the subsidence, is equal to the weight of the sediment deposited. Hence $(\rho_b-\rho_a)l=(\rho_a-\rho_s)s$; so that

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[1] Continued from p. 17.

$$\frac{l}{s}=\frac{\rho_a-\rho_s}{\rho_b-\rho} \text{ and } \frac{l+s}{s}=\frac{\rho_b-\rho_s}{\rho_b-\rho_a}.$$

Accordingly $l+s$ (the total thickness of the sediments)

$$=\frac{\rho_b-\rho_s}{\rho_b-\rho_a}s. \quad (1)$$

If, however, the subsidence be slowly deepened as the result of gentle lateral pressure, *compression-subsidence*, it is possible for a much greater thickness of deposits to accumulate without rising above sea-level than would be possible according to these calculations, and this appears not infrequently to happen. But it must be remembered that this downward movement imposed on the crust will cause the displacement of still more heavy plastic sima below, and the isostatic balance will be destroyed, because the sediments deposited are less in mass than the material displaced. There should, therefore, be a defect of gravity in areas of deposition affected by gentle lateral pressure. This is, in fact, the case in the Gangetic Plain, as well as in the low tracts lying east and north-east of the Andes.

The strength of the original crust, reinforced by the lateral pressure, may nevertheless be sufficient, for a time, to resist the upward pressure from below. But, if the horizontal forces cease to operate, the downward fold of the crust will ultimately yield to the pressure of the plastic material beneath, and the terrain will rise until isostatic adjustment is restored. It is not improbable that the alternation of marine and continental conditions which is so frequently observed may, in some instances at least, represent changes of this description accompanying intermissions and variations of moderate horizontal compression.

With a continuance, and still more with an increase, of compression, the exterior framework of the subsidence will gradually close, and throw the interior sediments, still soft and plastic, into folds of ever-increasing complexity. As these develop, the interior accumulations will tend to rise instead of sinking, and to pile themselves up into mountain masses concentrated on a limited portion of the earth's crust, which will be once more loaded in excess of the isostatic balance. A new subsidence—a *folding subsidence*—will ensue, with greatly increased displacement of the sima.

When the isostatic balance is once more restored, the summit of the mountain folds will still rise high above the adjoining plains; but a much greater portion will lie far below, and the protection of most of the sediments of the internal structure from future destruction will be still further assured.

Let, as before, ρ_a be the density of the sial and ρ_b that of the sima, and let j be the depth below the sea of the base of the mountain folds, consisting mainly of sediments, including for the present purpose both the rocks of the original surface of deposition and the later, interior, sediments; and let h be the height of the mountains above the sea, m the height of the plains, and c the thickness of the sial of which they are formed.

Then, in order to preserve isostatic balance, we must have

$$\rho_a c+\rho_b(j+m-c)=\rho_a(h+j). \quad (2a)$$

So $$\rho_b(j+m)-\rho_a(h+j)=(\rho_b-\rho_a)c. \quad (2b)$$

and $$c=\frac{\rho_b(j+m)-\rho_a(h+j)}{\rho_b-\rho_a}=j-\frac{\rho_a h-\rho_b m}{\rho_b-\rho_a}. \quad (2c)$$

The upper portion of the folds will commence to be eroded as soon as they rise above the surface, and will never reach the height which is obtained by continuing and completing the portion of the folding that can now be observed. Consequently, the base of the folds is not now and never has been so deep as would have been the case, but for the progress of erosion and consequent removal of load.

The gravitation data obtained by the Coast and Geodetic Survey of the United States in North America are best interpreted as indicating that the maximum depth of the folds is about 86 km. below sea-level. The average height of the crests may be taken as about 3500 m. above sea-level. We thus know roughly both j and h, but the value of c, the thickness of the sial of the plains, remains to be determined.

This amount is also concerned in the isostatic balance between the continental plains and the sea-bed. Let the depth of the sea outside the continental shelf be S, and the height of the plains above the sea be, as before, m. Then the mass of the sial below the plains must be in isostatic balance with the sea-water and the sima below it, down to the level of the base of the sial of the plains.

Hence

$$\rho_a c=\rho_s S+\rho_b(c-m-S) \quad (3a)$$

when ρ_s is, as before, the density of the sea-water.

So $$(\rho_b-\rho_s)S+\rho_b m=(\rho_b-\rho_a)c \quad (3b)$$

and $$c=\frac{(\rho_b-\rho_s)S+\rho_b m}{\rho_b-\rho_a}. \quad (3c)$$

But since $\rho_b(j+m)-\rho_a(h+j)$ also $=(\rho_b-\rho_a)c$, $\quad (2b)$

we have $$\rho_b(j+m)-\rho_a(h+j)=(\rho_b-\rho_s)S+\rho_b m. \quad (4a)$$

Hence $$\rho_b(j-S)=\rho_a(h+j)-\rho_s S \quad (4b)$$

and $$\rho_b=\frac{\rho_a(h+j)}{j-S}-\frac{\rho_s S}{j-S}. \quad (4c)$$

If h is taken as 3·5 km., j as 86 km., S as 4·7 km., and ρ_s as 1·03,

$$\rho_b=1{\cdot}10086\rho_a-0{\cdot}059545.$$

In view of the uncertainty of the data, these figures can only be regarded as a provisional approximation; but they are sufficient to indicate the general nature of the relation between ρ_b and ρ_a. The probable values of ρ_b for different values of ρ_a are shown in the first and second columns of the accompanying table.

With any corresponding values of ρ_a and ρ_b we can determine the value of c from either of the equations (2c) or (3c). These values are set out in the fourth column of the same table.

ρ_a. Assumed density of the sial	ρ_b. Corresponding density of the sima.	$\rho_b - \rho_a$. Difference.	s. Thickness in kilometres of the sial of the plains.
2·35	2·5275	0·1775	41·1
2·40	2·5825	·1825	41·4
2·45	2·6376	·1876	41·7
2·50	2·6926	·1926	42·0
2·55	2·7476	·1976	42·2
2·60	2·8027	·2027	42·5
2·65	2·8577	·2077	42·7
2·70	2·9128	·2128	43·0

It is remarkable how little the calculated thickness of the sial of the plains varies with the different values of the density of the sial and sima. It is considerably greater than the 15 km. deduced by Dr. H. Jeffreys from seismic considerations or the value assigned to it by H. Washington, 15 km. to 20 km., or, indeed, than I should myself have thought probable, but much less than the figures arrived at by Wegener. Although the data are only known approximately, it is difficult to see how the thickness can differ very considerably from 40 km., unless the depth, j, of the mountain folds is much greater and the difference $\rho_b - \rho_a$ less. For provisional purposes a density of 2·60 for the sial and 2·80 for the sima may be assumed. Such a density for the sima would imply that it is partly crystallised.

While the interior sediments of a subsided area are thrown into complex folds which sink ever deeper below the surface, the exterior rocks that formed the surface of deposition are forced down into hollows, which constitute folds simpler than those of the interior sediments and distinct from them. In the course of these movements they are stretched, and ultimately torn apart into lenticles. In addition, as a result of lateral compression and of isostatic adjustment, they may be and usually are fractured in thrusts and slip-faults. When the interior rocks have become compacted like those of the exterior, they too are forced to accommodate themselves by similar faulting to the forces acting upon them. Thrust-faults will predominate, and result in still further local accumulation in the subsided area and still further subsidence, a *thrusting subsidence*.

The approximate coincidence in the Boulonnais of the post-Jurassic infra-Cretaceous movements, as well as those of later date with the Hercynian folding, induced a number of observers, such as Godwin-Austen, Marcel Bertrand, and Charles Barrois, to formulate a law that movements tend to repeat themselves along the same tracts. That there is some truth in this principle cannot be denied. Unless folded rocks have been thoroughly consolidated and welded together, a renewal of the folding on the same lines will be comparatively easy, and in the case of faults it is a familiar fact that successive movements frequently take place along the same fault-plane. At the same time, T. O. Bosworth, in describing the relation of the Trias to the pre-Cambrian rocks of Leicestershire, has shown that the settlement of later rocks overlying an ancient ridge will cause deformation in the stratification more or less parallel to the contours of the surface of the older rocks. Probably still more important is the fact that the accumulation of the sediments at the foot of a mountain range will, on the principles already explained, tend to produce another system of folding parallel to the first. But this result will be controlled to a considerable extent by local conditions and more especially by the thickness of sial beneath; for it is probable that a sedimentation-subsidence forms more easily where the depth of the sial is less, as even at moderate depths and temperatures the sima is more yielding than the sial in the absence of volatile constituents. However, as Prof. Pruvost has shown, the correspondence is by no means so close, even in the Boulonnais, as to amount to identity of direction.

O. Barré, A. Bigot, and Paul Lemoine suggest the existence of a supplementary inverse principle, according to which an anticline succeeds to a previous syncline, and vice versa. This Lemoine illustrates by the buried ridge beneath the Thames Valley syncline and the supposed syncline beneath the Wealden anticline. But in the former case the synclinal axis is only approximately parallel to the ridge below it; and there is no reason to believe that the Palæozoic floor rises up on the south side of the Weald. It is far more likely that its descent on the northern side is in the nature of a monocline.

The tracts of folding and mountain building that I have discussed belong to great systems in different parts of the world with a direction approximating to the parallels of latitude, and would seem to owe their orientation to the meridional forces, which may themselves be attributed to variations in the angular velocity of the earth's rotation. I have no time to refer to the folds associated with the great ring of compression that encircled the Pacific in Mesozoic and early Kainozoic times. The position of this compression would appear to be determined by a general drift of continental masses towards the centre of that ocean, caused, I have suggested, by a maximum of gravitation beneath it.

To these two great systems of folding, their intersections and interference, may be referred nearly all the orographical features of the globe, which have come into being since the close of the Caledonian activity in early Devonian times; while the mountain ranges that belong to neither category not improbably owe their position and orientation to the existence of pre-existing ranges which have determined the development of new regions of folding in the manner already indicated. We know too little of the distribution and orientation of the continental masses and their relation to the position of the equator and the poles and to the variations of gravitation in older Palæozoic and still earlier times to enable us to say how far the directions of earlier folding are consistent with these suggestions.

I make no pretension to enunciate a new theory of mountain building. It has been my endeavour to tell a connected and consistent story of the steps by which mountain folds have come into existence and developed; how they owe their origin in general to great accumulations of sediments, the product of the denudation of the mountains raised in a previous period of folding; how a tract of subsidence resulting from sedimentation and filled by sediment becomes a tract of weakness in the earth's crust; how the time arrives when under the slowly increasing horizontal compression the subsided area yields and closes, so that the contained sediments are forced up in folds to form a new mountain range, while the earth's crust is left for the time being in a state of relaxation, at the mercy of minor forces which in the time of its strength it had no difficulty in resisting; how it is gradually consolidated once more by the reviving forces of compression, while new regions of weakness are being prepared by new accumulations of sediment, and another cycle of mountain building begins.

Obituary.

Sir William Augustus Tilden, F.R.S.

By the death of Sir William Tilden on Saturday, Dec. 11, in his eighty-fifth year, British chemistry lost one of its best known and most loved representatives. Born before Frankland had endowed the atom with valency, or Cannizzaro had used the implications of Avogadro's hypothesis to fix its relative weight, his span of life bridged the gulf between conceptions so widely separated as the indivisible unit of that remote time and the *congeries* of protons and electrons of the present day.

As a boy, Tilden was sent to various private schools and finished that part of his education at Bedford Modern School, where, during the two years of his stay, he helped to found the school scientific society, which bears his name. So far as can be ascertained, his interest in chemistry was first aroused by the experiments which a visiting tutor at the last of these private schools carried out in class to illustrate his teaching. Being given the choice of a career, Tilden in 1857, on leaving school, chose that of chemist. But through a confusion of ideas on the part of his guardian, more pardonable then than now, he started as the apprentice of a pharmacist, the late Alfred Allchin of Barnsbury in North London, who had been Redwood's assistant in the Pharmaceutical Society's School in Bloomsbury Square. He was therefore of the company of Scheele, Dumas, and others, who found their way to eminence in chemistry through the discipline and experience of the old type of pharmacy.

While attending classes at Bloomsbury Square during his apprenticeship, Tilden was attracted to Hofmann's lectures at the Royal College of Chemistry in Oxford Street, which opened up to him a new world and exercised a profound influence on his career. In 1862 he became assistant to Dr. John Stenhouse, F.R.S., but a year later returned to the School of Pharmacy, this time as demonstrator in chemistry under Attfield—a position he occupied until 1872, when, abandoning pharmacy for chemistry, he became science master at Clifton College under Percival, afterwards Bishop of Hereford. It may not be without interest to note that one of his students at Bloomsbury Square, the late W. A. Shenstone, F.R.S., who like himself had been a Jacob Bell Memorial scholar, succeeded him at Clifton.

From Clifton, Tilden went to Birmingham in 1880 as professor of chemistry and metallurgy in the newly founded Mason College and took an active share in the development of that institution; but in 1894, three years before it achieved university status, he was called to the chair of chemistry in the Royal College of Science, South Kensington, in succession to the late Sir Edward Thorpe. On his retirement from South Kensington in 1909—he had succeeded the late Prof. J. W. Judd, F.R.S., as Dean of the College in 1905—he received a knighthood and was given the title of emeritus professor in the Imperial College of Science and Technology. Thereafter, he occupied himself with literary work—chiefly studies in historical chemistry—and, for recreation, with his garden, of which he was justly proud. Among the more important of his books may be mentioned "Short History of the Progress of Scientific Discovery," published in 1899; "The Elements" (1910); "Chemical Discovery and Invention in the Twentieth Century" (1917); "Famous Chemists: the Men and their Work" (1920).

In the field of original research Tilden was first busied with subjects of pharmaceutical interest, out of one of which, the study of dilute nitro-hydrochloric acid, a method was developed in 1874 for the production of nitrosyl chloride in quantity, a reagent used largely by him in the investigation of the terpenes. Pinene nitrosochloride, the first of the additive compounds formed by its aid, was isolated by him in 1875, and others followed; but his work on these unsaturated hydrocarbons, and the conclusions reached about their constitution, are less likely to be remembered than his discovery of the polymerisation of isoprene into caoutchouc, which supplied the first clue to the manufacture of indiarubber by synthetical means. Among the other subjects which claimed his attention, mention may be made of his work on the relation of specific heat to atomic weight which formed the subject of the Bakerian lecture before the Royal Society in 1900. By awarding him the Davy medal in 1908, that Society set its seal on the merit of his contributions to knowledge.

Recognition also came to Tilden from universities and scientific societies. He received the honorary degrees of Sc.D. (Dublin), D.Sc. (Victoria), and LL.D. (Birmingham); became a fellow of the Royal Society in 1880; was a fellow of the University of London; corresponding member of the Russian Imperial Academy of Sciences; and honorary member of the Pharmaceutical Society; president of Section B (Chemistry) at the Bath meeting of the British Association in 1888; president of the Institute of Chemistry in 1891–94; treasurer of the Chemical Society in 1899–1903, and its president in 1903–5. His British Association address was noteworthy as an expression of his views on the teaching of chemistry; his tenure of the chair of the Institute of Chemistry for the adoption of the figure of Williamson's statue of Priestley in Birmingham for the seal of that body; and his presidency of the Chemical Society for the initiation of the invaluable series of "Annual Reports on the Progress of Chemistry," and of the movement for the admission of women to the fellowship, which, to his regret, was not endorsed by the Society until after the War.

Always sure of a welcome at any meeting he might attend, and listened to with pleasure when he intervened in discussions or debates, Tilden maintained his interest in chemistry and chemists to the end. Even when infirmity, which might have deterred many a younger man from making the effort, came upon him, he would travel from Northwood to attend meetings of the Chemical Society's council. These visits became less frequent as his sight began to fail, and after the summer of 1923 he was seen only once more at Burlington House, when, at the annual general meeting in 1924, as those who heard him will never forget, he made his last speech, rich in reminiscences of his early days as a fellow of the Society. To those who had the privilege of serving on his staff in Birmingham or London, he was ever the stimulating counsellor and appreciative chief. Nor were his students slow to recognise that in him they had a teacher who never spared himself in their interest, and, giving them of his best, he received in return that consideration which old-world courtesy invariably calls forth.

Sir William Tilden was twice married: first in 1869 to Charlotte, daughter of the late Robert Bush, and secondly, in 1907, to Julia Mary, daughter of the late C. W. Ramie. He is survived by Lady Tilden and by a son of the first marriage, Philip Armstrong Tilden, who has achieved distinction as an architect. The funeral at Northwood Parish Church on Wednesday, Dec. 15, was attended by a large body of mourners, including besides relatives the representatives of societies connected with chemistry, pure and applied, and many personal friends.

W. P. WYNNE.

SIR JAMES WILSON, K.C.S.I.

WE regret to record the death of Sir James Wilson, late of the Indian Civil Service, on Dec. 22 at his residence, Annieslea, Crieff. He was a recognised authority on a variety of topics connected with India —administrative, economic, philological, and ethnographic. After his retirement from the Indian service in 1911, when he settled in London, being keenly interested in agricultural matters, he acted as superintending inspector under the Board of Agriculture and Fisheries, and became a governor of the Agricultural Organisation Society; in 1914 he was appointed permanent delegate for Great Britain, Canada, Australia, New Zealand, and South Africa, to the Institute of Agriculture in Rome.

Sir James Wilson was born on Feb. 27, 1853, the son of the Rev. John Wilson, of Dunning, Perthshire. He was educated at Perth Academy and, after passing the Indian Civil Service examination in 1873, graduated at Edinburgh and then proceeded to Balliol College, Oxford, where he obtained the Boden Sanskrit scholarship, but did not stay long enough to take a degree. He went to India in 1875, and was posted to the Punjab. A distinguished administrative career, which included such high official appointments as secretary to the Punjab Government and the Financial Commissioner, membership of the Punjab Legislature, and, on Lord Curzon's selection, secretary to the Government of India in the Revenue and Agricultural Department, and finally Financial Commissioner of the Punjab, was recognised by the award of the C.S.I. in 1900 and the K.C.S.I. in 1909, two years before his retirement.

Apart from his official duties, Sir James Wilson's interest lay especially in investigating the dialects and folklore of his province. He wrote on tribal customs in the Gurgaon, Sisra, and Shahpur, compiled a gazetteer of the latter district, and wrote a grammar of Western Punjabi. Similar interests in folklore and dialect after his retirement produced "Lowland Scotch as Spoken in the Lower Strathearn District of Perthshire," published in 1915, "The Dialects of Robert Burns," and recently, "Scottish Poems of Robert Burns in his Native Dialect." He had also completed a book on the dialects of central Scotland.

WE regret to announce the following deaths:

Dr. Laurence Pullar, who, by a gift of £10,000, made possible the survey of the Scottish lochs carried out by the late Sir John Murray, and later, with Sir John, edited the six large volumes containing the results, on Dec. 22, aged eighty-eight years.

Dr. H. Campbell Ross, Director of the McFadden Research Foundation at the Lister Institute of Preventive Medicine, London, on Dec. 14, aged fifty-one years.

Mr. T. S. P. Strangeways, Huddersfield lecturer in special pathology and Director of the Research Hospital at Cambridge, on Dec. 23, aged sixty years.

News and Views.

THE New Year honours list includes the names of the following men of science and others associated with scientific work :—*Privy Councillor* : The Hon. W. G. A. Ormsby-Gore, Under-Secretary of State for the Colonies and president of Section E (Geography) of the British Association at the Oxford meeting in 1926. *Knights* : Dr. Henry Head, who has made distinguished contributions to our knowledge of the nervous system; Mr. A. E. Kitson, Director of the Geological Survey, Gold Coast Colony; Mr. J. C. W. Reith, Managing Director of the British Broadcasting Company; Dr. D. Milne Watson, Governor of the Gas Light and Coke Company, London. *K.C.B.* (*Civil Division*) : Dr. G. Macdonald, Secretary to the Scottish Education Department. *C.B.* (*Civil Division*) : Mr. H. T. Tizard, Principal Assistant Secretary, Department of Scientific and Industrial Research. *C.I.E.* : Lieut.-Colonel J. W. Cornwall, lately Director, Southern India Pasteur Institute, Coonoor, India; Mr. D. Anstead, Director of Agriculture, Madras; Mr. D. Milne, Director of Agriculture, Punjab. *K.C.M.G.* : Prof. W. Mitchell, Vice-Chancellor of the University of Adelaide, in recognition of his services to the Commonwealth of Australia. *C.B.E.* (*Civil Division*) : Mrs. Eugénie Strong, Assistant Director of the British School of Archæology in Rome.

LORD BALFOUR, on behalf of the Prime Minister, will receive a deputation on Feb. 15 from the British Waterworks Association, the Salmon and Trout Association, the Society of Medical Officers of Health, and other bodies, who wish to persuade the Government to set up a central authority to deal with the vexed question of river pollution in Great Britain. In our leading article of Jan. 1 we pointed out the necessity for scientific research in order to deal with many of the problems which present themselves, and outlined the preliminary investigations which have been carried out by the Select Committee on River Pollution during the last five years. The deputation will press for an extension of the relatively small amount of research already in progress, particularly in regard to the best methods of dealing with various harmful trade effluents. It would clearly be an advantage for the scientific investigations carried out by the State and dealing with water supply, sewage disposal, and river pollution, to be under one authority, since they are to a large extent interdependent. The movement towards keeping rivers free from pollution by industrial wastes is in no sense hostile to the industries causing the damage, the bodies concerned believing that the remedy is to be found in centralisation of effort and the application of scientific method to the many problems which have hitherto found no solution. The honorary secretary of the joint committee promoting the deputation is Mr. C. N. Hooper, Fishmongers' Hall, London Bridge.

THE opening of a public telephone service between London and New York this month proves that great progress has been made during the last two years by the radio engineers engaged on long-distance telephony. The charge is to be at the rate of £15 for three minutes' conversation and £5 for every additional minute. If other callers are waiting the speaker is limited to twelve minutes. If connexion be made with the number required but neither the person called nor a substitute accepted by the caller answers, a report charge of £2 only will be made. The problems that the engineers had to overcome mainly arose from the overloading of the ether with radio waves. The wave band chosen lies between 5000 and 6000 metres, and there are forty radio-telegraphic companies already taking up nearly all the available wave-lengths in this band. Very delicate switching devices controlled by the voice are used. When the London subscriber speaks, the circuit to New York is automatically switched on, and the circuit from New York to London is switched off. As soon as he ceases speaking the switches assume their normal position. When the New York subscriber replies, the converse operation takes place.

THE Post Office gave a very successful demonstra-of trans-Atlantic radio-telephony to the Press on Mar. 7 of last year, when for four hours conversation took place between English press representatives and their confrères in New York (see NATURE, Mar. 13, 1926, p. 387). The difficulties connected with atmospherics have not yet been completely overcome. The phenomenon of 'fading' occurs shortly after the time of sunset each day. It varies therefore with the season, occurring between 5 P.M. and 7 P.M. in winter, and between 8 P.M. and 10 P.M. in summer. When the time is 2 P.M. in Great Britain it is about 9 A.M. in New York. Hence between 2 P.M. and 6 P.M. the business times overlap. After this time, if the New York subscriber calls up, he will be put through to the London subscriber at his private residence. In the initial stages, however, it is not proposed to have a continuous twenty-four-hour service. The starting rates have been fixed on a commercial basis, and will be reviewed from time to time as experience is gained in working the service.

IN July last, Dr. W. J. S. Lockyer, director of the Norman Lockyer Observatory, Sidmouth, sent us a note giving the results of a comparison of the 50-day weather forecast for April-June prepared by Lord Dunboyne for the *Daily Mail*, with actual weather experienced. Sidmouth is in such a geographical position that the predictions for the division of Great Britain marked "England, S.W., Scilly Isles" on Lord Dunboyne's chart could be fairly applied to it. Dr. Lockyer therefore constructed a similar chart showing, on the same scale and for the same period, the weather forecast compared with fact. There was little resemblance between the two curves, but it seemed to us that the subject merited inquiry in more detail than Dr. Lockyer had been able to give to it. We therefore invited Capt. C. J. P. Cave to make such an examination over a longer period, and we were fortunate in obtaining his consent to do so. The results are described in an article which appears elsewhere in this issue, and the general conclusion reached is that the success or otherwise of the predictions is mainly a matter of chance. We sent Lord Dunboyne a copy of the article and offered him space for any comments he might care to make in reply to it. Lord Dunboyne, however, regretted that he had not the time to prepare such a reply, but his brother, Capt. the Hon. Robert Butler, has consented to do so, and we propose to publish his communication in an early issue.

EARLY on Jan. 1, a series of violent earthquakes disturbed the southern part of the Imperial Valley, which occupies the south-eastern corner of California and the northern part of Lower California, Mexico. Many buildings were destroyed in the border towns of Calexico and Mexicali, and water-mains were broken. It is estimated that about fifty shocks were felt during the first ten hours. The epicentre coincides very nearly, if not exactly, with that of the earthquakes of June 22, 1915, studied by Mr. Carl H. Beal (*Amer. Seis. Soc. Bull.*, vol. 5, 1915, pp. 130-149). On this day there were two violent shocks, both of intensity 9 (Rossi-Forel scale). The area disturbed by them was about 50,000 square miles, but the value of the property destroyed was only about one-third of that lost on Jan. 1. The Imperial Valley is almost entirely below sea-level and lies in a depression which, in recent geological times, was a branch of the Gulf of California. The district is traversed by some remarkable faults with a general north-west and south-east direction. One of these, the San Jacinto fault, apparently branches from the San Andreas rift, with which the Californian earthquake of 1906 was connected. It has been traced close up to the epicentral area of the earthquakes of 1915 and 1927, and is believed to traverse the Imperial Valley. Mr. Beal suggests that the earthquake of 1915 may have been caused by a displacement along this important fault.

Some results of importance obtained from a careful examination of the prehistoric monuments of the island of Minorca, which extended over a period of some months, are described by Mr. Frederick Chamberlin in the *Times* of Dec. 30. It has generally been held that the *talayots* of Minorca, great mounds of huge, rough uncemented stones 26 ft.-30 ft. high, were comparable with the better known *nurhags* of Sardinia. This comparison was based on the view that the *talayot* in some, if not all, cases was built hollow with an entrance, resembling in this respect a chambered cairn. Mr. Chamberlin examined 186 *talayots*, some previously unknown. Of these, 107 were in a sufficiently good state of preservation to permit him to say that 32 only, or one out of three, had ever had an entrance of any sort, while three alone had an interior chamber, and only one more than one apartment. It is clear, therefore, that the *talayot* is not comparable to the *nurhag* and, indeed, is a monument without a parallel. Associated with the *talayot*, and usually within a hundred feet of it, is a class of monument known locally as a *taula*—a two-stoned monument 5 ft.-12 ft. high in the shape of a Greek T, the flat top stone being fully 12 ft. long. Ten of these are now known. Each is surrounded by a horse-shoe-shaped wall pierced by a doorway surmounted by a single-stone lintel. The two classes of monument clearly stand in relation one to another, though there does not appear to be any evidence of orientation. Sir Wallis Budge has expressed the opinion that the *talayots* are pyramids of a funereal nature, and the *taulas* altars for sacrifice or other funereal ceremonies. A third class of monument, called *naus* from its resemblance to a ship, of which sixteen are known, has an elliptical chamber 15 ft. long by 7 ft. high, and appears to have served as a tomb for dwellers in the numerous caves in the neighbourhood.

The first five parts, constituting the first volume of the "Nomenclator animalium, generum et subgenerum," have now been issued by the Prussian Academy of Sciences. Each part consists of 160 pages, 12¼ × 9½ inches, printed in three columns with about 50 names to the page. The work will be completed in four more volumes and will contain more than 200,000 entries. It is hoped that the last part will be issued at the close of 1929. The promoters of this great work seem to have found some difficulty in making it known, and it has therefore been decided to extend to March 31, 1927, the term during which the names of subscribers will be received. The subscription price is 15 marks for each part, or 75 marks per volume. After that date the selling price will be raised to 20 marks a part. Payments should be made by cheque or money order to the Preussische Akademie der Wissenschaften, Berlin, N.W.7, Unter den Linden 38. The Academy also offers the "List of Literature" used in the "Nomenclature," for 10 marks; it occupies 288 pages. During the progress of this laborious undertaking, two successive editors, F. E. Schulze and W. Kükenthal, have died. The present editor-in-chief is Prof. K. Heider, and the secretary is Prof. Th. Kuhlgatz. Our readers may fittingly be reminded that the British Association, the Linnean Society of London, and a few individuals in Great Britain have helped the work by donations amounting to about £500.

It should scarcely be necessary for us to emphasise the extraordinary service that this publication renders to every working zoologist. It cannot, indeed, supersede Sherborn's "Index Animalium" in course of publication by the Trustees of the British Museum, a work which the German editors say "kann nicht genug bewundert werden." But the vaster scope of Sherborn's "Index," and the more exhaustive method by which it is compiled, indicate that no man living can expect to see its completion beyond 1850. The Prussian Academy, adopting a more rapid method, gives us a list of generic and subgeneric names down to 1922, those for the last twelve years being copied, without further reference, from the indexes to the "Zoological Record." The names of fossil animals are of course included, and almost excessive care has been taken to reproduce every variation in spelling down to obvious and ridiculous misprints. We have checked some of the earlier parts by other indexes accessible to us and have found an occasional date or page-number wrong (*e.g.* 1646 for 1846, 11 for 116), some initials incorrect, and the † indicating 'extinct' wrongly omitted or inserted. Such almost inevitable slips or misprints scarcely affect the usefulness of the work. Actual omissions are exceedingly rare, and if some unwarranted names have found their way in, they will do no great harm. Every serious student will continue, as heretofore, to verify his references. The great thing is to find the reference, and that is labour worth paying for.

According to a report of the Nairobi correspondent of the *Times* which appeared in the issue of Dec. 28, Mr. L. S. Leakey, of the Cutler Dinosaur Expedition, has discovered a complete human skeleton at Nakuru buried at a depth of twelve feet in the flexed position with knees drawn up to the chin. With the skeleton were more than a hundred stone implements described as 'Mesolithic,' mostly lunates and backed points of obsidian with a few bone points. The skeleton is that of a 6 ft. man and is said to be "not negroid." The skull has a nose of medium width and is not prognathous. Mr. Leakey is stated to regard this man as belonging to the "Wayland Magnosian" period of Uganda. Judging from the description, the implements would appear to belong to a type already found in this area which Mr. Wayland himself regards as comparable to Azilian. Mr. Leakey's work in investigating stone age remains in Uganda is being financed in part by the Percy Sladen Memorial Fund; but it is hoped that the interest which has been aroused by this discovery may call forth further financial assistance and also that the Kenya Government will agree to assist to a limited extent in 1927. Should the report be fully substantiated in all its details, the discovery is likely to prove of considerable importance in African archæology.

THE council of the *Field* Distemper Research Fund states that the investigations so far pursued have confirmed the view that canine distemper is caused by a filter-passing ultra-microscopic virus, and the symptoms of the disease itself have been disentangled from those of the many secondary infections that occur. Several puppies have been rendered so far immune by inoculation that infection afterwards with the virus produces only a slight and transitory effect. The material employed for the inoculation is at present of a crude nature and of uncertain and inconstant strength, so that the procedure has not yet reached the stage when it can be widely used, but progress in this direction is anticipated. The work is being carried out at Mill Hill in collaboration with the Medical Research Council; and the Duke of Portland, president of the Distemper Research Council, appeals for further donations to the fund, which should be forwarded to the organising secretary, Windsor House, Bream's Buildings, London, E.C.4.

WE have received the second annual report of the Board of Management of the London School of Hygiene and Tropical Medicine to the Court of Governors. The report, which is signed by Sir Alfred Mond, chairman of the Board, gives a brief account of the activities of the school and the progress made during the year. In the Tropical Division, Dr. Balfour reports that the extended courses of study have not led to any decrease in the number of students; in fact, the average number attending is slightly higher than last year. Since the Seamen's Hospital Society has signified its intention of maintaining the hospital at Endsleigh Gardens for a limited period only, the Minister of Health, upon representations made by the Board of Management, has appointed a committee to consider how the necessary clinical and pathological facilities for the study of tropical diseases can best be secured to the School. In order to increase the research work of the School, the Board has decided to apply the capital as well as the income of the Milner Research Fund to this purpose; as part of this plan, Dr. A. W. Grace has been nominated to proceed to the West Indies to undertake research on filariasis, and a contribution of £500 per annum for two but not more than five years has been made towards his expenses; the larger part of the cost of this expedition is being borne by the Royal Society. It is hoped that the formal opening of the Field Station of the Institute of Agricultural Parasitology, at Winches Farm, will soon take place; the work is under the intermediate direction of Prof. R. T. Leiper.

IT is satisfactory to learn from the report that the deficit taken over with the London School of Tropical Medicine has been wiped out, owing to an extra grant from the University Grants Committee and a donation from the executors of the late Mr. Alfred de Rothschild; but it is feared that the work of the Tropical Division cannot be carried on without loss, unless increased financial aid is forthcoming. Steps are being taken to enlarge the library, which at present is related entirely to the Tropical Division, so as to build up a library of hygiene, in advance of the opening of the new School. Unfortunately, the progress of the building has been seriously delayed by the coal strike, since the building committee, after careful consideration, felt they would not be justified in departing from their stipulation that only British steel should be used. However,, the steel work should be completed within twenty-five weeks of the termination of the coal dispute, that is, approximately by the middle of this year. Meanwhile, steps have been taken to make appointments to the chairs of bacteriology and immunology, and of epidemiology and vital statistics; thus the Board has the advice and assistance of the two professors, Prof. W. W. C. Topley and Prof. Major Greenwood respectively, in settling the details of the accommodation in the new school and its equipment. During the year Prof. McDowall, of King's College, has given courses of lectures in physiology as applied to hygiene. We welcome the report as evidence of the increasing part the School will play in university life in London.

DR. C. S. MYERS gives a very interesting and lucid account of vocational guidance and selection in the *Nineteenth Century* for November last. By vocational guidance is meant the expert advice offered to a person in regard to his choice of employment; by vocational selection is meant the discovery of the best worker for a given job. Dr. Myers discusses the effects of having 'the round peg in the square hole,' and rightly attributes much industrial discontent, unhappiness, inefficiency, and high labour turn-over to the presence of people in jobs for which they are intellectually and temperamentally unfitted. A high labour turn-over in jobs where security of tenure does not prevail is indicative quite frequently of bad selection. The only satisfactory reason for taking up a particular job is that one has the ability to do it and also that one prefers it to any other: such is, of course, a counsel of perfection, but it is impossible to overestimate the evil effects of forcing a child for reasons extraneous to the work itself or to the child into situations for which he is not adapted. The author points out that children are not, as a rule, the best judges of their capabilities or even interests, being frequently influenced by fashion, prestige, or fleeting interests. Teachers often do excellent work, but not all are either sufficiently gifted or trained for the necessary diagnosis.

OF recent year, special study has been devoted to the problems of guidance and selection, and it is now possible by the application of psychological tests to assess a child's abilities and advise accordingly. Dr. Myers wisely insists in his article that a mere mechanical application of tests is useless: they are of diagnostic value, but must always remain the servant, not the master, of the vocational adviser. Everybody who has come in contact with industry in its different fields has been impressed by the dissatisfaction of many who have had to enter an uncongenial trade or profession and are now too old to change. One point relevant to this discussion might be stressed, namely, that society as well as the individual parent must cease to look upon certain occupations as more respectable than others. How many miserable clerks would be happy as manual workers were it not that some grades of society consider clerical work more respectable than manual work?

THE Illumination Research Committee of the Department of Scientific and Industrial Research has issued Technical Papers Nos. 1, 2, and 3. dealing respectively with the terminology of illumination and vision, the transmission of window glasses and the effect of the enamelled steel reflectors used in works. The measurements on which the last two reports depend were made at the National Physical Laboratory by members of the staff. Of the importance and value of the two to industry there can be no doubt and they should command a ready sale. In a prefatory note to the first report the chairman of the Committee explains that as the technical terms used in illumination are not widely known, it has been thought desirable to publish explanatory notes so that readers of future reports would have full knowledge of the terms used in them. The prices of the three reports—9*d.*, 6*d.*, and 1*s.* respectively, seem high compared with the prices of corresponding publications of the United States Bureau of Standards or of those issued by the Support of Workings in Mines Committee of the British Mines Department, *e.g.* Paper No. 12 on Scotland, 24 pp., 4*s.* 2*d.* for 50 copies.

ARRANGEMENTS for courses of instruction in anthropology for the coming session are announced by the University of Paris. In view of the bias towards practical application in Colonial administration which is a feature of the work of the recently founded Institut d'Ethnologie, it is interesting to note that lectures are to be given there, beginning in late December or January, on descriptive ethnography by M. Mauss, descriptive linguistics by M. Marcel Cohen, anthropology by M. Paul Rivet, and extra-European prehistory by M. l'Abbé Breuil. The special provinces of French administration are covered by courses on the linguistics and ethnography of Africa, lecturer not stated, owing no doubt to the lamented death of M. Delafosse, and the linguistics and ethnography of eastern Asia and Oceania. The courses at other colleges and institutions of the University cover a wide range: in physical anthropology, M. Verneau on the races of the French Colonies; in ethnography, M. Mauss on the religions of non-civilised peoples, with special reference to Australian rites; M. Raynaud on the archæology of Central America and Peru, M. Cabaton on the Malays, M. Capitan on American ethnic affinities, and origins, M. Julien on Madagascar, M. Labouret on East Africa, M. Milliot on Morocco, and others. In sociology there are seven courses, including lectures by M. Granet on the extreme East, M. Massignon on Islam, M. Cabaton on Indo-China, and a general course by M. Fauconnet. There are some twelve or thirteen courses in various languages, and a course in prehistory will be given by M. G. Renard.

DR. EDWARD R. WEIDLEIN, Director of the Mellon Institute of Industrial Research, University of Pittsburgh, has been elected president of the American Institute of Chemical Engineers for the year 1927.

WE have recently received the annual report of Livingstone College, Leyton, London, E.10, for the year 1925–26. The College exists to instruct missionaries in the elements of medicine, and seventy-seven students took the various courses. The College paid its way except for about £35, but a deficit of £1375 still exists. A fund is being established to the memory of Dr. Harford, the first principal, and donations to this and for the general purposes of the College are asked for.

THE Rockfeller Foundation has published a fourth series of "Methods and Problems of Medical Education," dealing with the methods of obtaining, assembling, filing, and storing the record of the sick person. After a study of several admirable systems, that of the Presbyterian Hospital of New York City is believed to combine the maximum of aims to be attained and is set out in full detail with many facsimile reproductions. It combines not only a full history of the case while in hospital, but also means for following up the after history of a case after discharge.

THE annual analysis of books published in the British Islands during the past year which is issued by the *Publishers' Circular* shows that the total number of books published in 1926, namely, 12,799, was 403 less than that for 1925. This decrease, however, was due entirely to the smaller number of new editions, the total of actual new books, 9989, being slightly greater than in 1925. The number of books on science increased from 617 to 660, and those on technology from 609 to 629, while medicine remained the same with 399 publications, and agriculture decreased from 208 to 184. Scientific books included 20 translations and 83 new editions. Dividing the literature of 1926 into twelve main groups, fiction heads the list with the most publications, while science comes sixth and technology seventh. In 1914, science was third and technology fifth, and in 1925 the order was science seventh and technology eighth.

WE have received from Messrs. James Swift and Son (81 Tottenham Court Road, London) their catalogue of microscopes and accessories. Of microscopes, four models are constructed according to the specification of the British Science Guild; the 'Didaxis' is of new design, combining simplicity with strength and rigidity, and eminently suitable for students' use; the 'Universal Technical' is a high-class instrument particularly adapted for research work of all kinds. Two oil-immersion lenses of low aperture are catalogued, an $\frac{1}{8}$-in. N.A. 0·92 and a $\frac{1}{12}$-in. N.A. 0·95, which have been primarily designed for use with dark-ground illumination.

AMONG the works to be published early in the new year by the Cambridge University Press are "The Collected Papers of Sir James Dewar," in two volumes, edited by Lady Dewar, J. D. H. Dickson, H. M.

Ross, and E. C. Scott Dickson. The work will include not only the papers which appeared under Sir James Dewar's name alone, but those also which were published jointly with other investigators, excepting the series on spectroscopy by him and Prof. Liveing which have been issued separately. The same publishers also announce "Differential Geometry of Three Dimensions," by Prof. C. E. Weatherburn; Volume 2 of the second edition of "Principia Mathematica," by Prof. A. N. Whitehead and the Hon. Bertrand Russell; and a new volume in the series of Cambridge Mathematical Tracts, "The Theory of Integration," by L. C. Young.

The Report of the Director-General of the Ordnance Survey for 1925–26 has recently been published. In trigonometrical work a field section is at work restoring the primary and secondary trigonometrical stations and marking them by concrete blocks. This has been completed south of a line between the Wash and the mouth of the Severn. Good progress has been made with the work of recomputing the co-ordinates of the primary and secondary trigonometrical points on the Gauss conformal projection. A revision of the magnetic survey of Great Britain was begun in the Channel Islands. In map production the third revision of the one-inch map of England and Wales is complete, and of the 146 sheets, 145 have been published in the popular edition. The revision of the map of Scotland was nearly finished and 9 sheets of the popular edition were published. All sheets of the quarter-inch layer map are published, two more sheets of the revised half-inch map, and one out of three sheets of the new ten-inch map. Progress has been maintained in the revision of the six-inch map, which is now again being published in quarter sheets.

Applications are invited for the following appointments, on or before the dates mentioned:—Additional Research Fellows in the Department of Glass Technology, The University of Sheffield—The Registrar, The University, Sheffield (January 12). A laboratory assistant for photographic work, at the Building Research Station of the Department of Scientific and Industrial Research—The Director of Building Research, Building Research Station, Garston, nr. Watford (January 15). An assistant master, qualified in physics and mathematics, at the Royal Naval College, Dartmouth—The Headmaster of the College (January 26). A Warden of Goldsmiths' College—The Academic Registrar, University of London, South Kensington, S.W.7 (January 31). An assistant in entomology at the Pathological Laboratory of the Ministry of Agriculture and Fisheries at Harpenden—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1 (February 7). A professor of anatomy in the University of Adelaide—The Registrar, University of Adelaide, South Australia (March 1). A physicist in connexion with the Linen Industry Research Association, to take charge of a section dealing with finishing problems—The Secretary, The Research Institute, Lambeg, Co. Antrim.

Our Astronomical Column.

Comet Comas Sola.—The following is a continuation of the ephemeris for 0^h U.T.

	R.A.	N. Decl.	log r.	log Δ.
Jan. 8.	2^h 26^m 6^s	15° 13′	0·279	0·112
12.	2 28 48	16 4	0·276	0·121
16.	2 31 56	16 55	0·273	0·129
20.	2 35 48	17 48	0·270	0·138
24.	2 40 3	18 41	0·267	0·146

The brightness remains nearly constant, about mag. 12.

Mr. F. E. Cunningham supports the suggested identity with Spitaler's Comet 1890, vii., noting that Tisserand's criterion is satisfied.

Sunspot Activity, 1926–27.—The list of notable sunspots for the present year has already begun. A large spot, conspicuous also on account of its regularity of outline, was first seen during the last few days of December and was on the sun's central meridian in the forenoon of Jan. 1. The latitude of this spot was 7° S.; another large spot, also in equatorial latitudes, was reported in Nature of Dec. 25, 1926, p. 925. It is evident that large spot disturbances are now appearing within a comparatively wide range of latitude—a sure indication that the sun has entered upon the maximum phase of this cycle. Judging, however, from the average latitude of spots and faculæ of the past year, the highest peak of the curve will not be reached before the end of 1927. The spots of 1926 were considerable and show an increase in mean daily area of about 50 per cent. greater than that of 1925. Eleven groups of spots, large enough to be seen with the naked eye, were reported in these columns at the time of their respective appearances, but there were at least half-a-dozen other groups of almost equal importance.

Particulars of the recent spot are as follows:

No.	Date on Disc.	Central Meridian Passage.	Latitude.	Area.
1	Dec. 26–Jan. 7	Jan. 1·3	7° S.	1/1200 of sun's hemisphere.

Another Repetition of the Michelson-Morley Experiment.—Mr. Roy J. Kennedy describes in the November issue of the *Proc. U.S. Nat. Acad. Sciences* a repetition of this experiment. He reduced his light path to 4 metres (one-sixteenth of that employed by Prof. Dayton Miller), and enclosed the apparatus in an air-tight case, filled with helium at atmospheric pressure, thus reducing the disturbing effect of density changes to one-tenth of that in air. A further device used was raising one half of the surface of his mirror a small fraction of a wave-length, which was effected by cathode deposition of platinum. Experiments were made both at the Norman Bridge Laboratory, Pasadena, and in the 100-inch telescope building at Mt. Wilson. Observations were made at various times of the day, but most often at the time when Prof. Dayton Miller's conclusions would require the greatest effect. The effect at both stations was absolutely *nil*: "there was no sign of a shift depending on the orientation." Mr. Kennedy claims that a shift one-fourth of that announced by Miller would have been detected, and states that he will make further experiments to search for a possible shift in other directions.

Research Items.

Diffusion or Invention in Culture.—In *Psyche* (Oct. 1926), Dr. Bronislaw Malinowski has a most illuminating article on the life of culture, in which he attempts to show that the contrast insisted upon by some anthropologists between culture by 'diffusion' or by 'invention' is erroneous. He points out that every modern invention is made and re-made time after time in different places by different men. In the case of 'wireless,' though the invention is popularly ascribed to Marconi it can be traced back through Ampère, Faraday, Righi, Braun, Clerk Maxwell, Hertz, Lodge, and other workers. Thus the invention of radio communication can be treated as a single and singular event and ascribed to one man or another only by a misconception: the point of view of the Patent Office cannot rightly be taken up for the science of culture. Every cultural achievement is due to a process of growth in which diffusion and invention have equal shares. Culture is something always at work, which is there for the satisfaction of elementary human needs, which in turn creates new wants and provides means for their fulfilment. The value of so-called savage 'superstition' is to be found in the confidence that magical rite gives man in forgetting difficulties and in bridging gaps in his knowledge. Borrowing from others does take place, but whenever one culture borrows from another, it always transforms and readapts the objects and customs borrowed. Diffusion is modified invention, exactly as invention is a partial borrowing.

Puzzle Crazes.—In the *Nineteenth Century* (Dec. 1926) there is an interesting account by Mr. Henry E. Dudeney of puzzle crazes, with particular reference to the recent popularity of the 'cross-word puzzle.' He traces the development of pastime puzzles from very early days. One of the very oldest is what is now called the 'tangram,' known to the Chinese thousands of years before the Christian era. The Egyptians, too, were fond of puzzles, and there is in the British Museum a treatise of this nature called "Directions for knowing all Dark Things." Coming to more recent times, Niccola Fontana in the sixteenth century published a number of puzzles, some of which are still popular. Mathematical puzzles have interested numbers of people for centuries, while innumerable puzzles have been devised with string, matches, and coins. The word puzzles are for the most part restricted to the particular language in which they appear, and hence lack the universality of those of the mathematical type. Real puzzle acrostics do not appear earlier than the nineteenth century, but they were apparently popular at the court of Queen Victoria. Although puzzles, verbal or otherwise, have always been attractive, yet the popular craze for a particular type would seem to be modern, since it is dependent on easy locomotion, the Post Office, and cheap journalism. The 'cross-word' is not in its nature new, but in its present form it had its first success in the United States. The 'cross-word' is convenient in form, no apparatus being involved; each item can be complete in itself, *i.e.* one need not finish the whole puzzle at one sitting, and hence it is admirably adapted to modern forms of transit; it can be done in groups and hence is not a bar to sociability; there are an infinite number of possibilities, yet one does improve with practice; the habit is easily fixed, and there is constant challenge and stimulus. Sooner or later, the author thinks, the inveterate solvers will have acquired such a large and extended acquaintance with the words of the language that they will want something else. Then the 'cross-word' will end for this generation.

The Treatment of Syphilis.—Mercury has long been known as an effective drug in curing the obvious symptoms of active syphilis. Its use for this purpose has, however, been almost entirely given up since the discovery of the far more efficient salvarsan. Nevertheless, in some clinics it has been the custom, when all signs of the disease have been cured and the Wassermann reaction made negative, to follow up salvarsan treatment with a prolonged course of mercury in the hope of finally killing off any residual spirochætes and converting what may be a quiescent infection into a complete cure. In a very thorough study of the results of this procedure in 711 cases treated in Liverpool (Medical Research Council: Special Reports Series, No. 107. London: H.M.S.O., 3*s*. 6*d*. net), Prof. E. E. Glynn, Dr. R. E. Roberts, and Mrs. Bigland show clearly that mercury given in the later stages not only does not prevent relapses, but even actually encourages them. There is no evidence to show whether this is due to the breeding out of strains of the parasite resistant to mercury or to depression of the general health and resistance of the body; but it is an important practical point and raises some curious questions in pharmacology.

Acclimatisation and High Altitudes.—In his recent ascent of the peak of Kibo, the summit of Kilimanjaro, Mr. D. V. Latham was able to make some valuable observations on the physiology of the human body in high altitudes in the tropics. These observations, together with an account of the climb, are published in the December number of the *Geographical Journal*. The peak is 19,710 feet in altitude. Shortness of breath was felt first at 12,000 feet, but was never distressing even at 19,000 feet, and it was noticeable that the body became acclimatised to respiration in reduced pressure. At 18,000 feet, on the fourth day of the climb, breathing was less difficult than at 15,000 feet on the first day, but above 18,000 feet, especially when the gradient was steep, it was necessary to stop and rest after every forty paces. The pulse rate during rest at varying altitudes was not markedly altered and the blood pressure did not vary. Muscular power was diminished at 19,000 feet, where even slight efforts meant appreciable fatigue. Mental processes were also slow at the summit. Mountain sickness in one of the climbers did not appear until 19,000 feet, and in another it became so severe at 15,000 feet that he had to descend 3000 feet for two days' rest, after which he climbed to 17,200 feet before the symptoms returned. Mr. Latham believes that this difficulty can be overcome by gradual acclimatisation, and he does not think that it is due to oxygen-want, since the sickness was always relieved by walking, when the oxygen demand was greater than when resting. The paper contains also some interesting observations on red blood cells at different altitudes.

Asexual Reproduction without Loss of Vitality in the Organism of Bird Malaria.—Prof. R. W. Hegner (*Science*, 63, pp. 479, 480, 1926) records that *Plasmodium praecox*, the organism of bird malaria, has been met with several times in the United States in the common English sparrow. Whitmore in August 1913 obtained this organism from sparrows in New York and inoculated it into canaries, and Hegner obtained this strain in 1918 and has maintained it in canaries in his laboratory. In 1924 another strain was obtained by Hartman from a sparrow in Baltimore, and this also has been maintained in canaries. The asexual cycle of the New York strain has been shown to be thirty hours and that of the Baltimore strain twenty-four hours; whether the period of the former has become longer during its extended cultivation in canaries is not known. The number of asexual generations passed through by this strain since August 1913 is more than 3600. The Baltimore strain has passed through about 550 asexual generations and the periodicity seems to have been maintained unchanged, and this may be regarded as a measure of its vitality. Both the strains have maintained their virulence throughout the entire period. Prof. Hegner directs attention to the interest attaching to the rate of reproduction and to the virulence of these organisms living in a constant environment.

CRYSTAL STRUCTURE IN BIOLOGY.—Of considerable interest to biologists is last year's Mather Lecture of the Textile Institute delivered by Sir William Bragg on "The Fine Structure of Animal and Vegetable Substances as Revealed by the X-rays" (*Journal of the Textile Institute*, vol. 17, No. 11, Nov. 1926). The method used in the analysis of crystal structure has been applied to the study of cotton and wool fibres. In the case of ramie fibres the X-rays reveal the presence of multitudes of very minute crystals with some regularity of internal arrangement, in that a certain axis of each crystal is oriented along the main axis of the fibre. Otherwise the crystals are in complete disarray. Herzog (*Journal of Physical Chemistry*, April 1926, p. 457) found the unit pattern of a ramie fibre to be contained in a right-angled 'cell' calculated to weigh four times as much as the actual molecule of cellulose; so that the crystalline structure of the fibre is really very simple, and formed by the repetition of a fundamental unit of pattern containing only four cellulose molecules. The structures of such diverse materials as sugar crystals, rubber, and even chain compounds like fatty acids, have been analysed in the same way. From the point of view of the biologist, this is getting vegetable structure down very fine, and the method opens up a new avenue of approach to the investigation of at least some types of histological and causal problems (see also NATURE, July 24, 1926, p. 120).

THE ORIGIN OF FJORDS.—The vexed question of the origin of fjords was dealt with by Prof. J. W. Gregory in a lecture on the fjords of the Hebrides to the Royal Geographical Society on Dec. 20. While not denying that ice may have played a part in moulding the shape of fjords, Prof. Gregory insisted that other origins must be found for the valleys themselves. He pointed out that the direction of the fjords has no particular relation to the grain of the country, and that the main flow of the ice sheets was frequently across, and not along, the fjords. Fjords originated in rents or fissures due to earth movements. The nature of the earth movements gives a classification into three divisions. First are the rift valleys, due to the sinking of a strip of land between parallel faults; secondly are those valleys, due to a shattering of belts of rock by many tension clefts and the removal of the material by wind, water, and ice; and thirdly, the fjords due to the subsidence of a strip of country against one major fault producing an asymmetric valley. Prof. Gregory attributes the fjords of the Hebrides, like the sea lochs and fresh-water lochs of western Scotland, to the indirect effects of the Alpine folding of Oligocene and Miocene times, and the later Atlantic subsidences. To the Alpine movements was due the rending of the earth's crust, and to the later uplift of the British area was due the gaping of the fissures. The action of the surf along the shore and of erosive agencies inland has since modified these tectonic valleys.

BITUMINOUS SANDS OF NORTHERN ALBERTA.—A further report by Mr. S. C. Ells, of the Mines Branch, Department of Mines, Canada, describes his investigations of the well-known impregnated sands of the Fort McMurray region, on the Athabaska River, northern Alberta, up to the end of 1924. Although the deposits are very extensive, occupying more than 2000 square miles, not more than 3 square miles are readily accessible for commercial exploitation; the rest of the deposits lie beneath a thick overburden and would thus prove relatively expensive to operate. The percentage impregnation varies between 12 and 15, occasionally higher in limited areas. The report gives concise information on the character of the sands, also results of numerous laboratory determinations and analyses. Possibilities of economic development are considered, especially with reference to sources of fuel, power, transportation, markets and climatic conditions under which work would have to be prosecuted. Various processes have been designed to extract the bitumen from the sands, and for utilising the raw material in its natural condition; some of these processes are capable of extension and improvement to adapt them to large-scale operations, others are in the more experimental stage; all important ones, however, are reviewed in the report (No. 632), a document of 244 pages fully illustrated with photographs and diagrams. In addition there are 8 detailed maps and 4 cross-sections; the latter show the relative position of the sands with reference to overlying strata and the trend of present topography. After all the careful field and laboratory investigation which these Athabasca 'tar-sands' have received, particularly at the hands of the author, it will be very disappointing if at least a portion of the available resources cannot be profitably worked.

VACUUM TECHNIQUE.—The issue of the *Physikalische Zeitschrift* for November 1 contains an article of 20 pages by Mrs. M. A. Shirmann, of the Physical Institute of the University of Vienna, on two improvements which have been introduced recently into the technique of high vacua. When a vessel has been exhausted and has to be sealed off from the pump, the sealing process sets free from the heated surface of the glass a certain amount of gas which in general, as the seal is close to the vessel, gets into the vessel. By connecting the vessel to be exhausted by a narrow tube to the trunk tube of the pump and sealing off close to the trunk, only a small proportion of the gas liberated gets into the vessel. The second improvement relates to ground glass joints and to taps in which the seal is effected without mercury or grease. In the case of a joint, the inner cone may be metal or, if not, its outer surface is coated with metal; the outer cone has metal deposited on its outer surface, and between the two metal surfaces an electromotive force is applied which draws the two surfaces together. In the tap the plug is of metal, the outer surface of the barrel is coated with metal, and an electromotive force applied between the metals.

DECAY OF FLUORESCENCE.—In the *Ann. des Phys.*, No. 23, p. 681, 1926, E. Gaviola describes an interesting application of the Kerr phenomena. He shows that a satisfactory electro-optical arrangement may be devised to perform the function of the toothed wheel in Fizeau's measurement of the velocity of light. With this arrangement he has been able to show experimentally, for the first time, that stationary waves, established by a Lecher wire system, possess the wave-lengths predicted by Maxwell's theory. The main purpose of the method, however, was to investigate the rate of decay of the fluorescence of solutions of dyes, and Gaviola finds that the average duration of the fluorescence of solutions of rhodamin B and of uranin in glycerine and in water is of the order of 10^{-9} second. The effect of concentration on the rate of decay, if such an effect exists, appears to be very small.

The Pretoria Meeting of the South African Association for the Advancement of Science.

THE twenty-fourth annual meeting of the South African Association for the Advancement of Science took place at Pretoria on July 5-10, 1926, under the presidency of Dr. E. T. Mellor. The meeting was very well attended, and 129 papers were read. Joint meetings of several sections were held. A popular lecture was given by the Hon. J. H. Hofmeyr, Administrator of the Transvaal, on "The Romance of Ægean Archæology." There was a reception by the Mayor and Mayoress of Pretoria, a conversazione by the Pretoria branch of the South African Biological Society, and visits to various places of scientific interest in the neighbourhood.

The president, Dr. E. T. Mellor, in his address, gave an account of "Science in Relation to Mining and other Industries in South Africa." He indicated how modern scientific thought and methods have entered into the everyday life of the people instead of being restricted to the laboratory. The Witwatersrand goldfield, he said, is probably the most concentrated and important one in the world, and in the development of South Africa, gold and diamond mining has played a very important part. Gold being stabilised in price, and with an unlimited market, permits friendly rivalry in efficiency of mines. Geology has benefited from mining through the study of auriferous conglomerate and the origin of gems. Deep-level mining yields information on rock temperatures at great depths. In physiology the effects of moisture and temperature on health have been studied. In pathology the study of respiratory diseases has been of greatest general benefit. Anthropology even has benefited as a result of mining. The discovery of deposits of platinum is the result of a geological survey. The importance of industrial research was indicated, and, in concluding, the president pointed out that science is not local but universal, and commended it as a life career of greatest interest.

"The Problem of Atmospheric Electricity" was chosen by Prof. P. G. Gundry for his presidential address to Section A. In speaking of pure and applied research, he stated that it is scarcely too much to say that no great forward step is ever made without being based on the work of those spurred by scientific curiosity alone. The place of South Africa in pure research such as astronomy is largely due to amateurs, to whose work also much of our knowledge of the electrical condition of the earth and its atmosphere is due. The Heaviside layer of the atmosphere, radio telegraphy, and the earth's electric field were discussed at length, as was recent work on very penetrating rays of cosmic origin. Ionisation of the air and Wilson's work on thunderstorms were described, and the suitability of South Africa for the study of thunderstorms was indicated.

Dr. St.C. O. Sinclair gave an account of "The Chemical Service of the Union of South Africa: its Organisation and Work" as his presidential address to Section B. This service is distributed between the staffs of the Division of Chemistry, the Schools of Agriculture, the Veterinary Research Institute and an industrial chemist. The Division of Chemistry has to undertake work for State departments, such as agriculture, justice, finance, public health, mines, posts and telegraphs. The staffs of the schools of agriculture act as research officers, teachers and extension officers. Biochemical problems and poisonous plants are dealt with at the Veterinary Research Institute. The systematic soil survey of the Union, brak investigation in relation to irrigation schemes, fertiliser experiments, the making of synthetic manure, investigation of the composition of fruit and its export under the best conditions, preservatives, tanning materials and prickly pear destruction were all discussed. The scope of the regulatory work of the Government Division ranges from work on food adulteration to the preparation of chaulmoogra oil esters for the treatment of leprosy.

The subject of Prof P. A. van der Bijl's address to Section C was "Landmarks in the Development of the Science of Plant Pathology and Disease Control." Researches on fungoid diseases of plants, dealing with life-histories, biological races, disease resistance, mechanism of penetration by parasites and variations under environmental conditions, were discussed, as were bacterial plant pathogenes. Mosaic and protozoal diseases were also considered. The history of control measures against plant diseases was given and their importance indicated. The attention given to the study of plant diseases in different countries was noted, and the advantages to a country of systematic instruction through university training in plant pathology, as in America and South Africa, were indicated.

The presidential address to Section D was delivered by Prof. C. G. S. de Villiers, his subject being "Some Aspects of the Morphology and Ontogeny of the Skeletogenous Strata." The need of correlation of comparative anatomy, comparative embryology, phylogenetic palæontology and experimental zoology in investigations of the morphology of the chordates was first indicated. Neoteny was discussed and the origin of the mesodermal skeleton reviewed fully. The differentiation of the mesenchyme and the various views on the morphology and origin of the sternum in Amphibia were indicated. The ontogeny of the tissue giving rise to the zonal and appendicular skeleton is as yet unknown, though probably mesenchymatous. The nature of membrane bones requires further investigation. Phylogenetically, membrane bones are older than cartilage bones, and whether they acquire secondary relations to zonal, sternal, cranial or visceral skeleton, they are remnants of the original exoskeleton. Ontogenetically they may be derived from the cutis layer of the myotome. The use of the experimental method was noted. The solution of many obscure problems in osteology can only be solved when a clearer knowledge is obtained of the earliest differentiation of the mesodermal skeletogenous strata.

"The Need of a Scientific Basis for South African Native Policy" formed the subject of Mr. J. D. Rheinallt Jones's presidential address to Section E. Students of native policy in the past have been largely guided by historical considerations leading to partisanship. New lines of research are needed. The primitive mentality of natives needs careful study to determine if qualitative differences between the European and Bantu mind may be present. Levy-Bruhl's hypothesis of total difference in orientation of the native mind from that of the European was discussed. There appears to be something incompatible between the foundations of primitive culture and those of modern civilisation, but this does not necessarily prove that the difference is absolute and not one of degree. The modes of alteration of primitive mind were discussed, as was animism and its effects. The necessity for anthropological and psychological research was stressed.

Dr. S. Evans discussed "The Politician and Political Economy" in his presidential address to Section

F. The present misfortunes of many countries are, he said, due to ignorance and contempt for elementary economic principles by responsible authorities during and since the War. Lack of experience in subject or administration is no disqualification for ministerial responsibilities. Rhetorical idealism still has more power over the mind than knowledge or reason, and rhetoricians become ministers with power to interfere with the conduct of industries and commerce, of which they know nothing. The primary producers always suffer most from ignorance of the principles of political economy by those in power, and by support of sheltered industries at their expense. Europeans are not coming for agriculture to South Africa, as conditions which repel the capitalist have been created, and over-taxation of the mining industry has checked them and curtailed the profitable operation of gold. The probable life of the Witwatersrand goldfield was discussed. Johannesburg is becoming more independent of the mines, but their decreased spending power will affect the whole of South Africa adversely, unless made good by expansion in some other direction. The necessity of a policy to foster private enterprise and to introduce foreign capital and European immigrants for development of industries was urged.

The next annual meeting of the Association will be held under the presidency of Prof. H. B. Fantham, professor of zoology in the University of the Witwatersrand, Johannesburg, Transvaal, at Salisbury, Southern Rhodesia, in July 1927.

[The above brief summaries of the presidential addresses to the sections were sent by Prof. H. B. Fantham, who included also the names of authors and the subjects of papers read before the various sections. We regret that limitations of space prevent us from printing this account of the sectional proceedings.—ED. NATURE.]

The Fisheries of Ceylon.

DETAILS of the marine biological research carried out by the Ceylon Government are contained in the reports for 1924[1] and 1925.[2] In the first of these reports is an account by Commander J. C. Kerkham, the Marine Superintendent, of the Government research vessel *Nautilus*. This, a German-built steam trawler 132 feet in length, has been fitted out with laboratory accommodation and apparatus for carrying out scientific trawling, dredging, and hydrographic investigations. In addition she is equipped with a steam-driven, direct-expansion ammonia refrigerating plant with two insulated chambers for the storage of fish.

A biological survey, commenced in 1920 by the Government trawler *Lilla* and continued by the new trawler, has been fruitful in disclosing the possibilities of two fishing banks, the Wadge and the Pedro: some results of a survey of these banks are given by Dr. Pearson and his assistant biologist, Mr. Malpas, in the 1924 report, and more details are now given in a further paper.[3] The banks give a combined area of 3000 square miles, with an average depth of 25 to 50 fathoms. The advantage to be gained by the employment of two steam trawlers by the Government is shown, calculations being based on a conservative estimate of 1¼ tons and 1¼ tons of fish caught per diem for the respective banks. Steam trawling should not seriously affect the fisheries of the native fishermen—not only because the grounds are too far afield for them, but also because they fish chiefly for drift-net and line-caught fish that are not captured in the trawl. In 1925 actual catches were carried to Colombo in the cold-storage chambers of the research steamer, and it was demonstrated that the fish arrived in good condition and that a ready sale was obtained for them. It is considered that if an assurance of a steady supply of fresh fish could be guaranteed to passenger shipping using Colombo as a port of call, the present spasmodic demand made by them would become regular; and it is believed that the prosperity of the trawling industry would depend on the measure of support given by the shipping. The employment of up-to-date fishing methods is therefore urged.

In somewhat less hopeful vein comes the report for the Pearl Fisheries of 1925,[4] in which is an interesting account by Dr. Pearson of the previous scientific investigations from the time of the late Sir William Herdman's survey in 1902 to the present day. Dr. Pearson critically reviews the situation and puts forth his own views on the matter. The pearl fisheries in the past have been essentially intermittent, only 39 fisheries having taken place in 125 years. It was such fluctuation that was responsible for the failure of the ill-fated Ceylon Company of Pearl Fishers that started operations in 1905, burdened amongst other things with the pledge to spend between £3000 and £10,000 annually on cultural and experimental research. It has been the aim of scientific inquiry to seek the causes of this irregularity and hence, if possible, a remedy, so as to ensure a productive regularity in the industry.

Chief among the suggestions put forward has been that of the employment of cultural methods such as those used in the oyster industry of Arcachon. Dr. Pearson takes the view that previous workers have been unduly optimistic in their hopes and considers that the site and conditions of the Ceylon pearl fisheries are such that cultural methods *in situ* are out of the question, and that the fisheries must mainly be controlled by natural agencies. In this he is probably right, seeing that the pearl oyster is essentially a deep-water shellfish compared with the Portuguese oyster at Arcachon, which lives in the tidal zone. The fact that the pearl-oyster grounds are extremely narrow may be of great significance in the irregularity of the supply, since the two maximal spawning periods occur when the south-west and north-east monsoons are respectively at their highest, and the pelagic larvæ may be carried far from suitable ground by currents. To control the fall of spat in the open sea is beyond human power. As James Steuart said in 1843: "It is only when, in the infinite wisdom of the Creator of all things, the oyster brood descends upon the banks suited to nourish and support it . . . that it comes within our power to watch its advancing age . . ."

However, given a successful spat fall a good fishery is not necessarily ensured; in late life the oyster beds are liable to decimation, as Dr. Pearson shows by figures for the crops in recent years. Two of the greatest dangers to the growing crop are perhaps the action of currents, which may uproot the oysters from the ground or carry sand which becomes deposited and silts up the beds, and the inroads of such shellfish-eating fish as rays, a species of which, incidentally, carries one stage of the parasite that infects the oyster and so gives rise to pearls.

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[1] Ceylon Administration Reports for 1924. Part 4: Education, Science and Art (F).

[2] Administration Report of the Government Marine Biologist for 1925. By Dr. Joseph Pearson. Pp. F16. (Colombo: Government Record Office) 35 cents.

[3] Sessional Paper 14, 1926. Prospects of Trawling in Ceylon. Pp. 12. (Colombo, Government Record Office.) 20 cents.

[4] Ceylon. Sessional Paper 15, 1926: Reports on the Pearl Fishery of 1925 By Dr. Joseph Pearson. Pp. 80+11 plates (Colombo: Government Record Office) 1·25 rupees.

This is not to say that research in the past has been valueless nor that it is no longer necessary. It is very evident that scientific investigations are of the utmost importance in watching the histories of the various beds and deciding the most economic periods at which to fish them. There would still seem to be room, too, for a more detailed study of the habits and conditions required for the successful development of the oyster in the laboratory on the lines of the work now being carried out by the Ministry of Fisheries in Britain in its oyster research station at Conway.

The fishery in 1925, which appears to have been unfortunate owing to the failure of many divers to arrive at the beginning and to unfavourable weather conditions, brought in a net profit of Rs.1,67,017.

Interesting data on the growth of the pearl oyster are given; information arising from a number of linear measurements and weight determinations tends to lower the previous estimates of the ages of different-sized oysters.

It is gratifying to note that the staff of marine biologists attached to the Ceylon Government is growing, and we hope for much information of interest on tropical marine life in the future. F. S. R.

University and Educational Intelligence.

CAMBRIDGE.—Prof. A. E. Taylor of the University of Edinburgh has been appointed Leslie Stephen lecturer for the year 1927. Mr. H. Claye, Gonville and Caius College, has been appointed an Assistant Registrary.

Application should be made before June 1 to the Senior Tutor, St. John's College, by any graduate of another university seeking admission as a research student who wishes to be a candidate for the Strathcona Research Studentship of £150 a year at St. John's College.

The entrance scholarships and exhibitions awarded at twelve colleges at the end of last term include 33 for mathematics and 33 for natural sciences out of a total of 169 awards; other awards were 54 for classics, 24 for history, and 21 for modern languages.

LONDON.—The following courses of free public lectures are announced: "Current Views on Internal Secretion," by Prof. Swale Vincent, at the Middlesex Hospital Medical School, on Jan. 14, 18, 21, and 25, at 4 o'clock; "Biological Action of Light," by Dr. D. T. Harris, at University College, on Jan. 20 and 27 and Feb. 3, at 5 o'clock; and "Cytology in relation to Physiological Processes," by Dr. R. J. Ludford, at University College, on Jan. 20 and 27, Feb. 3, 10, 17, and 24, at 5.30 o'clock.

Mr. E. Matthews has been appointed demonstrator in the Chemistry Department of Guy's Hospital Medical School.

STATISTICS of universities, colleges, and professional schools in the United States are published biennially by the Federal Bureau of Education. In the 913 institutions which figure in the returns for 1923–24, published in *Bulletin* No. 45, 1925, the total number of students enrolled in that year amounted to 726,124, including 268,423 women. Of the 913 institutions, 144 were under public control, and these enrolled 255,630 students, of whom 88,770 were women, whilst privately controlled institutions enrolled 470,494, of whom 179,653 were women. There were also enrolled 189,943 additional students in summer schools, 4012 in winter short courses, and 140,846 in extension and correspondence courses. Turning back to the similar bulletin issued two years ago, one finds that the number of institutions reporting was then only 780. The addition of 133 reports "is due in part to the efforts of field agents of the Bureau of Education, who secured many reports by personal visits." This detracts somewhat from the value of the statistics for purposes of comparison of one period with another, and points to the futility of the comparisons that are sometimes made between the student statistics of different countries.

THE Report for the year 1925 of the Calcutta School of Tropical Medicine, Institute of Hygiene, and the Carmichael Hospital for Tropical Diseases, contains, in addition to a review by the Director, Lieut.-Col. J. W. D. Megaw, of the work carried out at the School since its opening in November 1920, a list of articles (nearly a hundred) published by members of the staff during the year, separate reports of the specially endowed researches in relation to kala-azar, hookworm, bowel diseases, leprosy, and diabetes, reports by the Superintendent of the Pasteur Institute (which has been so fully employed in the treatment of patients that it was unable to undertake research) and by professors in charge of departments. The School is said to be the only institution in India adequately equipped for post-graduate teaching of tropical medicine and hygiene, and for training young medical research workers, and, as such, it serves the needs of the whole of the Indian Empire. The endowment fund amounted at the end of the year to more than eleven lakhs of rupees (nearly £90,000), and the receipts of the year included an anonymous donation of one lakh of rupees, in addition to handsome contributions by the commercial communities of eastern India and by Indian noblemen and merchants. The expenditure of the year amounted to Rs.1,19,904, of which Rs.1,02,834 was on account of salaries.

THE Departmental Committee on Education and Industry appointed by the Minister of Labour and the President of the Board of Education jointly, has issued an interim report dealing with the machinery available "for enabling young persons to enter into and retain suitable employment." The principal elements of this machinery are the juvenile employment committees of those local education authorities which have decided to exercise their powers under the Choice of Employment Act and the juvenile advisory committees, appointed by the Ministry of Labour, in areas where no such decision has been taken. Since 1921 the administration of unemployment insurance for boys and girls up to the age of 18 years has been linked with the choice of employment work, so that one and the same local authority must be responsible for both. One of the chief recommendations made in this report is that central responsibility for both should likewise be vested in one and the same authority, namely, the Ministry of Labour, instead of being shared, as at present, with the Board of Education. Other recommendations are: To consider the setting up of a National Advisory Council for Juvenile Employment, on which local education authorities should be strongly represented; to encourage the application of psychological tests; to cause a special inquiry to be undertaken regarding the transfer of juvenile labour from one area to another; to establish a scheme for juvenile unemployment centres on a permanent basis; and not to permit either recourse to compulsion to secure the attendance of unemployed juveniles of 14 years and 15 years at courses of instruction, or the payment of maintenance allowances to juveniles attending unemployment centres or other approved courses.

Calendar of Discovery and Invention.

January 9, 1729.—While holding the Savilian professorship of astronomy at Oxford, Bradley attempted to detect the annual parallax of the fixed stars. Hooke at Gresham College, and Molyneux at Kew, attacked the same problem, and Bradley collaborated with the latter. He then erected a zenith sector at Wanstead. The observed movement of the stars for a time baffled him, but after much thought he was able to explain what he saw by his important discovery of the aberration of light; a discovery which was communicated to the Royal Society on Jan. 9, 1729, in the form of a letter from Bradley to Halley.

January 10, 1849.—Some of the earliest experiments in submarine telegraphy were made by Wheatstone, Sömmering, Morse, and Colt, but it was the introduction of the use of guttapercha by Werner Siemens which made submarine cables practicable. On Jan. 10, 1849, C. V. Walker, of the South-Eastern Railway, laid two miles of cable in the Channel off Folkestone, and by this and a land line of 83 miles communicated from a ship with London. There are now more than 300,000 miles of submarine cables in use.

January 11, 1816.—It was the terrible explosion at Felling Colliery, near Sunderland, in May 1812, which led to the formation of a Society for Preventing Accidents in Coal Mines through which Davy's attention was attracted to the subject. His investigation of the properties of fire-damp and the passage of flame through tubes, and his invention of the wire-gauze safety lamp, were described to the Royal Society on January 11, 1816. Many improvements in miners' lamps have been introduced since, giving greater safety and more light. In 1924 it was recommended that lamps should have 0·8 candle-power, and in recent years electric lamps have been largely adopted.

January 12, 1727.—On this day two hundred years ago died Jacob Leupold, of Saxony, famous for his skill in constructing mathematical instruments and machines. His great work, "Theatrum Machinarum," was published in 1723-1727. The contemporary of Savery and Newcomen, Leupold was the first to suggest a high-pressure steam engine. His sketch shows an engine with two pistons working two force pumps through beams, the distribution of steam being controlled by a four-way cock.

January 13, 1800.—Founded through the instrumentality of Rumford, the Royal Institution was incorporated on Jan. 13, 1800. The name Institution was adopted in imitation of the Instituto of Bologna, while its purpose was "for diffusing the knowledge and facilitating the general introduction of useful mechanical inventions and improvements, and for teaching, by courses of philosophical lectures and experiments, the application of science to the common purposes of life." Its early development as a research institution was due to Davy and Faraday.

January 15, 1876.—In the Science Museum, South Kensington, is preserved the apparatus with which Andrews, of Belfast, made his famous experiments on liquids and gases and discovered the existence of a critical temperature. His work was done in the 'sixties. Writing to him on January 15, 1876, Kelvin said: "We are all greatly delighted in my laboratory with what you have given us—my old assistant MacFarlane is in raptures to see carbonic acid compressed to the liquid state in that always ready way. It will be a splendid lesson to my students, and I think that henceforth they will every lesson know more of the meaning of liquids and gases and vapours than I have ever been able to teach them." E. C. S.

Societies and Academies.

LONDON.

Royal Microscopical Society, November 17.—**M. T. Denne**: A new apparatus for casting paraffin imbedding blocks. It consists of a jacketed chamber in the upper surface of which troughs are formed, fitted with frames or 'lifters,' and adapted to receive the wax. A second reservoir contains water heated to a definite temperature by gas or electricity, and this is so arranged that it may be raised to fill the jacketed chamber or lowered to empty it. In operation, the hot water is caused to enter the jacketed chamber, the troughs are filled with melted paraffin, and the objects arranged in the ordinary way or oriented under a Greenough binocular, the paraffin being maintained at the correct temperature meanwhile. When ready, the reservoir receives the hot water, and cold from a main supply is forced into the jacket causing very rapid cooling. A second momentary application of the hot water from the reservoir frees the blocks by superficial melting, and they are lifted out of the troughs.—**C. Tierney**: Caballaro's technique for mounting diatom and other type slides. The method consists essentially in manipulating the specimens with a fine hair in a hermetically sealed chamber attached to the microscope. A petri dish with a raised platform in the centre, on which the specimens and prepared cover-glass are placed, is filled with mercury. From the nosepiece of the microscope is suspended a wire carrying the hair and a glass cylinder which, when the body-tube is lowered, enters the mercury, thus forming a sealed chamber free from all air currents, condensation, and dust particles.

PARIS.

Academy of Sciences, November 22.—**Émile Borel**: A theorem on systems of linear forms with skew symmetric determinant.—**C. Matignon** and **Mlle. G. Marchal**: The heat of oxidation of beryllium. Starting with the pure metal prepared by the method of Stock, Praetorius, and Priess, the heats of solution in hydrofluoric and hydrochloric acids were determined, from which the heat of formation of beryllium oxide is deduced as 140·3 calories. Based on this figure, the heats of formation of various beryllium compounds have been recalculated.—**Georges Claude** and **Paul Boucherot**: The utilisation of the thermal energy of the sea. At depths of 1000 metres the temperature of the sea water is between 4° C. and 5° C., and in the tropics that of the surface between 26° C. and 30° C. The possibility of utilising this temperature difference to work a low-pressure turbine is discussed, and some experiments described in which a low-pressure steam turbine was made to work between the temperatures 0° C. and 28° C.—**Léon Guillet**: The addition of nitrogen to steel. In an earlier paper the case hardening of certain steels by the action of ammonia at 500° C. is described: the present communication gives measurements of hardness (Brinell) of these steels under varying conditions.—**Tilho**: The Nile at the borders of Tibesti near the centre of the Libyan desert (explorations of Prince Kemal el Dine).—**Paul Montel**: The domain corresponding to the values of an analytical function.—**Maurice Janet**: The possibility of plunging a given Riemannian space of n dimensions into a Euclidian space of $\frac{1}{2} n (n+1)$ dimensions.—**Léon Pomey**: The integration of a system comprising an infinity of ordinary differential equations with an infinity of unknowns.—**N. Podtiaguine**: Regularity of growth [of functions].—**A. Toussaint** and **E. Carafoli**: The kinematographic spectra of the plane flow of fluids round varied obstacles.—**A. Véronnet**: The rotation of a heterogeneous mass.

Evolution and fractionnation. The case of Jupiter and Saturn.—P. Helbronner: The twenty-first and twenty-second campaigns of the detailed geometrical description of the French Alps.—Th. Vautier: The increase of intensity and the duration of extinction of sound.—Léon Bouthillon: Radiogoniometers and radiophares with accentuated maximum.—L. Longchambon: The rotary power of tartaric acid. Discussion of a recent note on the same subject by E. Vellinger. Details are given of the changes in the rotary power of tartaric acid produced by dilution down to a concentration 0·00625. A tube 10 metres long was used in these measurements.—J. Galibourg and F. Ryziger: Contribution to the study of the Röntgen spectrography of pearls. A discussion of a Röntgen spectrograph as a means of distinguishing natural from cultivated pearls.—P. Mercier: The particles of long path emitted by the active B+C deposit of actinium.—Neda Marinesco: Some properties of large molecules in solution.—Charles Dufraisse and Paul Gailliot: Peculiarities of the fractures of acrolein gels: rhythmic production of ridges. Fractured surfaces of acrolein gels, examined under the microscope, show remarkable regularities, the surface being covered with parallel, equidistant straight lines resembling a ploughed field. These surfaces form a diffraction grating (about 120 lines to the millimetre) and give spectra both by transmission and by reflection. A spectrograph of mercury vapour obtained with such a grating is reproduced.—Tiffeneau and Mlle. J. Levy: The desamination of some phenyl-amino-alcohols, C_6H_5.CH(OH).CH(NH_2)R. Preparation of acylophenones without transposition.—Pierre Jolibois: The constitution of the organo-magnesium compounds. In an earlier communication (*C. R.*, 1912, p. 353) the author has given reasons for preferring the formula $Mg(C_2H_5)_2.MgI_2$ to the more generally admitted $Mg.C_2H_5.I$. Work for and against this view published since 1912 is summarised, and the work of Job and Dubien, which supports the formula $Mg.C_2H_5.I$, is adversely criticised.—V. Ipatief and N. Orlof: The hydrogenation of xanthone and xanthene.—Y. Altchidjian: The utilisation of liquid fuels containing a high proportion of organic sulphur compounds as a source of an antidetonating combustible. It is suggested that from the work of Midgley and Boyd, organic sulphur compounds might be expected to act as antidetonants in internal combustion motors: this conclusion has been confirmed by experiments with mixtures of petrol and heavy oils containing sulphur obtained by carbonisation of bituminous limestones.—N. Menchikoff: Primary strata to the south of Oued Drâa.—Const. A. Kténas: The chemico-mineralogical nature of the enclosure of Fouqué-Kaméni (Santorin).—Pierre Allorge: The benthos with desmids of the lakes in the west and centre of France.—Pierre Dangeard: The variation of the plates (carapace) in Peridinium.—J. Magrou: The anatomy of plant cancer or crowngall.—Raoul M. May: The reaction velocity of *Calliactis effoeta* in the presence of alkaloids and of gland extracts.—P. Delauney: The biochemical synthesis of a chlorinated glucoside, β-5 chlorosalicyl glucoside.

Official Publications Received.

British and Colonial.

The Manchester Museum. Museum Publication 92: The 'Behrens Collection of Sumerian Tablets in the Manchester Museum. By T. Fish. (Notes from the Manchester Museum, No. 30.) Pp. 6+12 plates. 1s. 6d. Museum Publication 93: Report of the Museum Committee for the Year 1925–26. Pp. 20. 6d. (Manchester: At the University Press; London: Longmans, Green and Co., Ltd.)

Third Annual Report of the Research Association of British Flour-Millers, 1925–1926 (July 1st to June 30th). Pp. 24. (St. Albans, Herts; London: 40 Trinity Square, E.C.3.)

Journal of the Indian Institute of Science. Vol. 9B, Part 3: Aerial Testing. By J. K. Catterson-Smith. Pp. 21-28+11 plates. 1.8 rupees. Vol. 9B, Part 4: Circulating Currents in Wave-wound Armatures. By F. N. Mowdawalla and G. K. Pradhan. Pp. 29-35+18 plates. 1.8 rupees. Vol. 9B, Part 5: Madras (Fort) Radio Field Intensity Measurements at Bangalore. By K. Sreenivasan. Pp. 37-50+12 plates. 3 rupees. (Bangalore.)

Union of South Africa: Department of Agriculture. Science Bulletin No. 50: Some Physical and Chemical Changes occurring during the Ripening of Grapes (Second paper). By P. R. v. d. R. Copeman and G. Frater. (Division of Chemistry Series No. 67.) Pp. 54. 9d. Science Bulletin No. 51: Factors Influencing Overrun. By D. J. Retief. Pp. 24. 3d. (Pretoria: Government Printing and Stationery Office.)

Aeronautical Research Committee. Reports and Memoranda. No. 1031 (M. 42): The Torsion of Circular and Elliptical Cylinders of Homogeneous Æolotropic Materials. By S. J. Wright. Work performed for the Engineering Research Board of the Department of Scientific and Industrial Research. (E.F. 176.) Pp. 5. 4d. net. No. 1035 (M. 44): Report on the 'Burning' of Aluminium. By J. D. Grogan. Work performed at the National Physical Laboratory for the Engineering Research Board of the Department of Scientific and Industrial Research. (B.1.a. Metals, Strength and Properties, 52.—T. 2306.) Pp. 12+3 plates. 1s. net. (London: H.M. Stationery Office.)

South Australia. Annual Report of the Director of Mines and Government Geologist for 1925. Pp. 9. (Adelaide: R. E. E. Rogers.)

Canada. Department of Mines: Mines Branch. Investigations of Mineral Resources and the Mining Industry, 1925. (No. 669.) Pp. ii+84. Bituminous Sands of Northern Alberta: Occurrence and Economic Possibilities. Report on Investigations to the end of 1924. By S. C. Ells. (No. 632.) Pp. vii+244+43 plates. 75 cents. Bituminous Sands of Northern Alberta. Topographical Maps (to Accompany Report No. 632.) 12 maps in Case. Sodium Sulphate of Western Canada: Occurrence, Uses and Technology. By L. Heber Cole. (No. 646.) Pp. vii+160+15 plates+22 maps. 40 cents. (Ottawa: F. A. Acland.)

Dove Marine Laboratory, Cullercoats, Northumberland. Report for the Year ending June 30th, 1926. Edited by Prof. Alexander Meek. (Published by the Marine Laboratory Committee of Armstrong College.) Pp. 44+2 plates. (Cullercoats.) 5s.

British Photographic Research Association. Report for the Year 1925–26. Pp. 16. (London.)

The Journal of the Institution of Electrical Engineers. Vol. 65, No. 360, December. Pp. 96+xxviii. (London: E. and F. N. Spon, Ltd.) 10s. 6d.

Foreign.

Smithsonian Miscellaneous Collections. Vol. 78, No. 4: Opinions rendered by the International Commission on Zoological Nomenclature. Opinions 91 to 97. (Publication 2871.) Pp. 30. Vol. 78, No. 4: Solar Activity and Long-Period Weather Changes. By Henry Helm Clayton. (Publication 2874.) Pp. 62. Vol. 78, No. 5: The Distribution of Energy over the Sun's Disk. By C. G. Abbot. (Publication 2876.) Pp. 12+1 plate. (Washington, D.C.: Smithsonian Institution.)

Department of Commerce: U.S. Coast and Geodetic Survey. Serial No. 330: Coastal Currents along the Pacific Coast of the United States. By H. A. Marmer. (Special Publication No. 121.) Pp. iv+80. (Washington, D.C.: Government Printing Office.) 15 cents.

Department of the Interior: U.S. Geological Survey. Water-Supply Paper 580-A: Geology of No. 3 Reservoir Site of the Carlsbad Irrigation Project, New Mexico, with Respect to Water-Tightness. By Oscar E. Meinzer, B. Coleman Renick and Kirk Bryan. (Contributions to the Hydrology of the United States, 1926.) Pp. iv+39+2 plates. Bulletin 782: Ore Deposits of the Jerome and Bradshaw Mountains Quadrangles, Arizona. By Waldemar Lindgren, with Statistical Notes by V. C. Heikes. Pp. ix+192+23 plates. 50 cents. Professional Paper 142-A: The Molluscan Fauna of the Alum Bluff Group of Florida. By Julia Gardner. Part 1: Prionodesmacea and Anomalodesmacea. Pp. iv+79+iii+15 plates. Professional Paper 142-B: The Molluscan Fauna of the Alum Bluff Group of Florida. By Julia Gardner. Part 2: Astartacea, Carditacea, Chamacea. Pp. iv+81-99+i+plates 16-17. 10 cents. Professional Paper 142-C: The Molluscan Fauna of the Alum Bluff Group of Florida. By Julia Gardner. Part 3: Lucinacea, Leptonacea, Cardiacea. Pp. iv+101-149+ii+plates 18-23. Professional Paper 142-D: The Molluscan Fauna of the Alum Bluff Group of Florida. By Julia Gardner. Part 4: Veneracea. Pp. iv+151-184+ii+plates 24-28. Professional Paper 147-A: A Comparison of the Genera *Metaplacenticeras* Spath and *Placenticeras* Meek. By John B. Reeside, Jr. (Shorter Contributions to General Geology, 1926.) Pp. ii+5+2 plates. Professional Paper 147-B: The Montana Earthquake of June 27, 1925. By J. T. Pardee. (Shorter Contributions to General Geology, 1926.) Pp. ii+7-23+plates 3-12. 20 cents. (Washington, D.C.: Government Printing Office.)

Catalogues.

Splices and Tapes for Rubber Insulated Wires. Pp. 16. (Passaic, N.J.: The Okonite Co.; London Agents: Wm. Geipel and Co.)

List No. 148: Cambridge Dissolved Oxygen Recorder for Boiler Feed Water. Pp. 4. (London: Cambridge Instrument Co., Ltd.)

Diary of Societies.

FRIDAY, January 7.

Geologists' Association (at University College), at 7.30.—Dr. G. Slater: Glacial Tectonics as reflected in Disturbed Drift Deposits: Studies in the Drift Deposits of the South-Western Part of Suffolk. Part 2 and 3.

SATURDAY, January 8.

Royal Institution of Great Britain, at 3.—Prof. A. V. Hill: Nerves and Muscles: How we Feel and Move: (6) Speed, Strength, and Endurance.

MONDAY, JANUARY 10.

Royal Society of Edinburgh, at 4.30.—Frances M. Ballantyne: Air-Bladder and Lungs: a Contribution to the Morphology of the Air-Bladder of Fish.—Dr. G. Slater: (a) The Structure of the Disturbed Deposits of Møens Klint, Denmark; (b) The Disturbed Glacial Deposits in the Neighbourhood of Lønstrup, near Hjørring, North Denmark.—E. L. White: The Fish-Fauna of the Cement-Stones of Foulden, Berwickshire.

Institution of Electrical Engineers (Informal Meeting), at 7.—Discussion: L. Henshaw: The Earthing of Metal Objects other than Conductors.—S. W. Melsom: The Earthing of Electrical Circuits.

Institute of Metals (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.

Institution of Electrical Engineers (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.30.—Prof. W. M. Thornton: What is Electricity? (Faraday Lecture).

Institute of Metals (Scottish Local Section) (at 39 Elmbank Crescent, Glasgow), at 7.30.—Prof. J. H. Andrew: The Value of Research.

Surveyors' Institution, at 8.—F. G. Baxendale: The Effect on Values of Town Planning Schemes in their Various Stages.

Royal Geographical Society (at Æolian Hall), at 8.30.—Sir Arnold Wilson: A Periplus of the Persian Gulf.

Institution of the Rubber Industry (London Section) (at Engineers' Club, Coventry Street).—G. Martin: Ageing of Raw and Vulcanised Rubber.

TUESDAY, JANUARY 11.

Institution of Petroleum Technologists (at Royal Society of Arts), at 5.30.—Dr. L. Dudley Stamp: The Conditions Governing the Occurrence of Oil in Burma.

Institution of Civil Engineers, at 6.—Prof. Douglas Hay: The Economics of Power-Production and Utilisation at Collieries.

Illuminating Engineering Society (at Lighting Service Bureau, 15 Savoy Street, W.C.2), at 6.30.—W. J. Jones, H. Lingard, and T. Catten: Floodlighting.

Institute of Marine Engineers, at 6.30.—Sir Robert Hadfield: Progress in the Development and Practical Application of Heat-resisting and Non-corroding Steel.

Institution of Electrical Engineers (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—J. R. Beard and T. G. N. Haldane: The Design of City Distribution Systems and the Problems of Standardisation.

Institution of Electrical Engineers (North-Western Centre) (at Engineers' Club, Manchester), at 7.

Institution of Electrical Engineers (Scottish Centre) (at North British Station Hotel, Edinburgh), at 7.—Dr. A. Ekstrom: The Applications of Electricity to Agriculture (Lecture).

Institute of Metals (Birmingham Local Section) (at Engineers' Club, Birmingham), at 7.—H. S. Caswell: Forces set up in Strip Rolling.

Royal Photographic Society of Great Britain (Scientific and Technical Group), at 7.—L. Joseph: The Empire Model 5 Projector.

Society of Chemical Industry (Birmingham and Midland Section) (at Birmingham University), at 7.15.—C. H. Wood: A Study of the Rotatory Dispersion of Certain Derivatives of Hydroxyacids.

Society of Chemical Industry (South Wales Section) (at Technical College, Cardiff), at 7.30.—W. R. D. Jones: Magnesium and its Alloys.

Institute of Metals (North-East Coast Local Section) (at Armstrong College, Newcastle-upon-Tyne), at 7.30.—U. R. Evans: Some Aspects of the Corrosion of Metals.

North-East Coast Institution of Engineers and Shipbuilders (Middlesbrough Branch) (at Middlesbrough), at 7.30.—W. G. Richards: Rivets and Riveting.

Quekett Microscopical Club, at 7.30.—Dr. G. H. Rodman: Insectivorous Plants and How they Live.

Pharmaceutical Society of Great Britain, at 8.—J. H. Franklin: Notes on Preparations of the British Pharmacopoeia, 1914.

Röntgen Society (at British Institute of Radiology), at 8.15.—R. J. Reynolds: Some Experiments on the Production of Rapid Serial Skiagrams from the Screen Image by means of a Cinematograph Camera.

Institute of Chemistry (Manchester and District Section) (at Manchester).—Prof. J. B. Cohen: Air Pollution.

WEDNESDAY, JANUARY 12.

Royal Society of Arts, at 3.—Prof. C. R. Darling: The Story of a Wireless Valve (Dr. Mann Juvenile Lectures) (2).

Royal Society of Medicine (Surgery: Sub-Section of Proctology), at 5.30.—Dr. E. U. Williams and L. E. C. Norbury: Normal Variability of the Action of Pituitrin on the Contractile Power of the Caecum and Colon.—L. E. C. Norbury and C. N. Morgan: The Value of Lipiodol in Determining the Extent of Fistula-in-ano.—R. Maingot: Gummatous Colitis.—Dr. C. Dukes: Laboratory Tests for the Diagnosis of Cancer of the Rectum and Colon.—W. B. Gabriel: (a) Volvulus of the Pelvic Colon and Blind Caecostomy; (b) Skin Grafts for Fistulae.

Institution of Civil Engineers (Informal Meeting), at 6.—F. H. Livens: Dragline Excavators.

Society of Chemical Industry (Nottingham Section, jointly with Fuel Section) (at University College, Nottingham), at 7.—Dr. J. G. King: The Production of Liquid Fuels from Coal.

North-East Coast Institution of Engineers and Shipbuilders (Graduate Section) (at Bolbec Hall, Newcastle-upon-Tyne), at 7.15.—J. E. Conner: The Erection of a Rotary Portland Cement Kiln.

THURSDAY, JANUARY 13.

Royal Society, at 4.30.—F. W. R. Brambell, A. S. Parkes, and Una Fielding: Changes in the Ovary of the Mouse, following Exposure to X-Rays. Parts I. and II.—A. S. Parkes: On the Occurrence of the Oestrous Cycle after X-Ray Sterilisation. Part II. Irradiation at and before Birth.—R. M. Sargent: Recovery from Vigorous Exercise of Short Duration.—F. A. Pickworth: Basal Metabolism as determined by the Respiratory Exchange.—M. Dixon: On the Mechanism of Oxidation-Reduction Potential.—R. G. Canti and M. Donaldson: The Effect of Radium on Mitosis *in vitro*.—Dr. R. J. Ludford and W. Cramer: Secretion and the Golgi Apparatus of Islets of Langerhans.—S. Dickinson: Experiments on the Physiology and Genetics of the Smut Fungi. Hyphal Fusion.—Y. Azuma: (a) Effects of C- and K-Ions and Ultra-violet Rays upon Involuntary Muscles; (b) Effects of Ultra-violet Rays upon Skeletal Muscles.

London Mathematical Society (at Royal Astronomical Society), at 5.—P. Dienes: On Cartan's Torsion of a Tensor Space.—J. E. Littlewood: On the Class-number of the Corpus $P(\sqrt{-k})$.—L. J. Mordell: On Power Series with the Circle of Convergence as a Line of Essential Singularities.—N. Wiener: (i.) The Spectrum of an Arbitrary Function; (ii.) On a Theorem of Bochner and Hardy.

Society of Chemical Industry (Manchester Section, jointly with Institution of the Rubber Industry) (at 16 St. Mary's Parsonage, Manchester), at 7.—Dr. D. F. Twiss: Rubber Solvents.

South London Entomological and Natural History Society, at 7.

Institution of Mechanical Engineers (Glasgow Branch) (at Royal Technical College, Glasgow), at 7.30.—Prof. T. Gray: The Present Position of the Low Temperature Carbonisation of Coal.

Institute of Metals (London Local Section) (at 83 Pall Mall), at 7.30.—Dr. W. Rosenhain: Hardening.

Optical Society (at Imperial College of Science), at 7.30.

Oil and Colour Chemists' Association (at 8 St. Martin's Place, W.C.2), at 8.—H. W. D. Ward: Cadmium Colours and their Application to the Paint Industry.

Royal Society of Medicine (Neurology Section), at 8.30.—Dr. A. Turner and others: Discussion on Epilepsy.

Institution of Mechanical Engineers (Leeds Branch).—F. C. Turner: A New Load-Strain Recorder.

Institution of Mechanical Engineers (Birmingham Branch).—Informal Discussion.

FRIDAY, JANUARY 14.

Royal Astronomical Society, at 5.—Dr. J. K. Fotheringham: Some New Determinations of the Secular Accelerations of the Sun and Moon.—S. D. Tscherny: Occultations of Stars by the Moon, observed at the Astronomical Observatory, Kiew, in the Year 1926.

Malacological Society of London (at Linnean Society), at 6.

North-East Coast Institution of Engineers and Shipbuilders (at Newcastle-upon-Tyne), at 6.—Hon. Sir Charles A. Parsons and R. J. Walker: Progress in Economy of Turbine Machinery on Land and Sea.

Institute of Metals (Swansea Local Section) (at University College, Swansea), at 7.15.—Discussion on Pyrometers.

Junior Institution of Engineers, at 7.30.—R. L. Kirlew: The Thermionic Valve and its Characteristics.

Institute of Metals (Sheffield Local Section) (at Sheffield University), at 7.30.—P. Hopkinson: Gas Furnaces and their Heating.

Society of Chemical Industry (Chemical Engineering Group) (at Chemical Society), at 8.—J. A. Hall: Thermo-Electric and Resistance Pyrometry in Industry.

Philological Society (at University College), at 8.—Rev. A. Darby: Functional Grammar.

Colour Chemists' Association (Manchester Section) (at Manchester).—A. W. C. Harrison: Lake Dyestuffs and their Application.

SATURDAY, JANUARY 15.

North of England Institute of Mining and Mechanical Engineers (at Neville Hall, Newcastle-upon-Tyne), at 3.—J. S. Carson: Dry Cleaning of Coal.

PUBLIC LECTURES.

SUNDAY, JANUARY 9.

Guildhouse (Eccleston Square), at 3.30.—Dr. A. B. Cook: Animism.

THURSDAY, JANUARY 13.

King's College, at 5.30.—Prof. J. S. Huxley: The Mind: Biology.

FRIDAY, JANUARY 14.

Middlesex Hospital Medical School, at 4.—Prof. Swale Vincent: Current Views on Internal Secretion. (Succeeding Lectures on January 18, 21, and 25.)

SUNDAY, JANUARY 16.

Guildhouse (Eccleston Square), at 3.30.—G. A. de Zoysa: The Soul of Buddhism.

CONFERENCE.

JANUARY 10 AND 11.

Society for Experimental Biology (at Bedford College, Regent's Park).

(First Session) *Monday, January* 10, at 2.15 to 3.45.—G. C. Robson: Some Effects of Competition and Selection.—Prof. A. E. Boycott: Experiments on the Habitats of Planorbis and Bithinia.—R. E. Chapman: The Relation of Bicarbonates to the Photosynthesis of Water Plants.—At 3.45 to 4.30.—Demonstrations:—Prof. W. Neilson Jones: Fungal Cultures (Mycorrhizal) grown in Atmosphere (a) containing, and (b) free from, Gaseous N_2.—Dr. M. C. Rayner: Aseptic Conifer-Seedlings.—M. A. Tazelaar and Prof. J. S. Huxley: Effect of Temperature Gradients upon Early Development in the Chick.—J. Hammond: The Fate of Foetal Tissues grafted into the Uterus of the Rabbit.—At 4.30 to 6.—W. K. Slater: Aerobic and Anaerobic Metabolism of the Common Cockroach.—J. Needham: Carbohydrate Metabolism of the Developing Egg.

(Second Session) *Tuesday, January* 11, at 10 A.M. to 1 P.M.—Prof. J. S. Huxley, M. Shaw, M. Perkins, and J. T. Cunningham: Symposium: The Relative Growth of Parts.—At 2.15 to 3.45.—Dr. C. M. Yonge: Intracellular Digestion in the Metazoa.—G. F. Marrian: On Haemerythrin: the Respiration Pigment of Phascolosoma.—At 4.30 to 6.—G. P. Wells: The Actions of Cations on Invertebrate Muscle.—V. J. Clancey: Recent Advances in the Study of the Scleroproteins.

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Television.

THE lecture delivered by Mr. J. L. Baird on Jan. 6 at the Physical and Optical Society's annual exhibition was very largely attended, and had to be repeated the same evening in order to prevent widespread disappointment. The attendance was a tribute to the intrinsic interest of the subject and to the expectations aroused by what little has become known of the lecturer's apparatus and achievements.

Mr. Baird did not add to the general knowledge by what he said and did on that occasion. The situation appears to be that he has achieved a certain success in transmitting instantaneous images divided into some thirty vertical strips, each strip showing more or less correct gradation in a vertical direction. The picture composed by the strips is therefore very coarse-grained in one direction while sufficiently graded in a direction at right angles to it. The most important point about the transmission is that it uses diffusely reflected light, and not the light transmitted, say, by a lantern slide. To the latter transmission Mr. Baird will not consent to apply the term 'television' at all, and in this we consider he is justified. The eye itself normally sees objects by diffusely reflected light, and television, to be worthy of the name and to accord with popular expectation, must do the same.

Now this proviso is a very serious obstacle to overcome. For the 'candle-power' of a brightly illuminated face is approximately unity, whereas in kinematograph projection it amounts to thousands. True television, as defined by Mr. Baird, is therefore at least a thousand times more difficult than the transmission of shadows of moving objects such as has already been achieved by several inventors, among whom Ruhmer was the first in 1907.

Mr. Baird appears to have succeeded in transmitting images of objects artificially illuminated to an extent equivalent to bright sunlight, and to have overcome the difficulties of synchronisation in transmitting and receiving within the same building. He also claims to have accomplished similar transmissions by radio over about ten miles, and to have transmitted living faces showing considerable detail. While giving him all credit for his very direct attack on a difficult problem, and for what he has demonstrably achieved, we must guard against an underestimate of the remaining difficulties. These will affect such things as synchronism, illumination, and detail.

It is comparatively easy to keep two motors running at the same speed, even at a distance. But when a difference of phase of only one degree is capable of spoiling definition, the maintenance of the correct phase becomes a formidable task. Granted that Mr. Baird transmits the equivalent of 30,000 signals per second as against the 300,000 required for satisfactory television, it is easily seen that the problem of synchronism may become sufficiently acute to bar further progress. The figure of 300,000, on which most workers on this problem are agreed, is based upon the fact that a face alone, to be recognisable, requires some 3000 graded elements. Most press portraits comprise at least 10,000 such elements; and in order to produce the illusion of continuity or motion, there must be at least sixteen transmissions of the whole picture per second.

From the information available—and it must be remembered that Mr. Baird has not disclosed the essential details of his method—it appears highly probable that little further progress need be expected along the lines chosen by him. The illumination seems to have been driven to its farthest limit, and the recent claims to have transmitted 'outlines' by infra-red rays mark no advance towards television with diffusely reflected light. The subdivision of the image by a disc of spirally staggered lenses seems incapable of extension, and the suggestion thrown out in the course of the lecture, that several photo-electric cells (and several radio-frequencies) might be used simultaneously, only serves to emphasise difficulties already known to exist.

It is to be regretted that, possibly on account of patent considerations, Mr. Baird has hitherto been unable to submit to a proper authentication of his claims by a learned society. For aught his recent audience could say, the invention might be a mere plaything, with no more resemblance to television than a toy engine has to the real thing. That is not the way to convince a sympathetic audience of experts who are expected to judge of the merits and prospects of an invention.

There are at least three pioneers in the field who seem to be on the verge of a complete solution of the television problem. Belin in France, and Alexanderson and Jenkins in America, are all approaching the problem by way of the transmission of photographs, which they accomplish in great perfection. Dr. Alexanderson, chief engineer of the Radio Corporation of America, claims to be able to transmit a complete photograph in one second, and points out that if sixteen successive photographs could be transmitted in one second, the problem of television (or, at least, of telekinematography) would be solved. He adds, however, that the difficulties, especially of synchronism, increase as the square of the speed.

It is well to remember that the earlier solutions proposed after the discovery of the light-sensitive property of selenium did not require the synchronisation of moving parts at the sending and receiving stations. But a multiplicity of wires, one for each picture element, is out of the question, and so is a multiplicity of radio-frequencies. Unless, therefore, some device such as Dr. Fournier d'Albe's acoustic resonator system can be employed for the simultaneous reception of a medley of signals, the question of synchronism, effective both in speed and phase, will arise; and when we realise that the synchronism required is that of two 'pencils' which traverse the picture completely in a sixteenth of a second, and in doing so describe several hundred lines, the mechanical difficulties may well appal us. The speed with which the stimulus can be applied at the transmitting end is great enough nowadays, for the action of a photo-electric cell shows no appreciable lag, and the use of a Braun cathode ray tube at the receiving end, first suggested, we believe, by Mr. Campbell Swinton, will solve the speed problem there.

There remains the problem of sensitiveness to illumination at the receiving end. Mr. Baird does not tell us what he uses. His results suggest a potassium photo-electric cell for ultra-violet, and either selenium or bolometer for the infra-red. If he has discovered any reagent of greatly superior power, that discovery alone would entitle him to our gratitude, and would constitute a valid claim even though all his other devices had been anticipated by others. The policy of withholding publication of an essential item does not commend itself to modern inventors. It savours too much of medieval practice, and usually defeats its own object of securing to the inventor the fruits of his invention.

It would be a source of satisfaction to us if one of our countrymen were the first to provide a practical solution of a problem of this magnitude, a solution such as the civilised world has been expecting for some years. If the solution has been reached without the scientific, engineering, and financial resources at the disposal of rival inventors, it will appeal very powerfully to our sympathy and imagination. But for the present, and on the evidence supplied, the scientific world will probably prefer to reserve its judgment.

Is Darwinism Dead?

(1) *A Companion to Mr. Wells's "Outline of History."* By Hilaire Belloc. Pp. iv + 119. (London: Sheed and Ward, 1926.) 7*s*. 6*d*. net.

(2) *Mr. Belloc Objects to "The Outline of History."* By H. G. Wells. (The Forum Series.) Pp. vii + 55 + 2 plates. (London: Watts and Co., 1926.) 1*s*. net.

(3) *Mr. Belloc still Objects to Mr. Wells's "Outline of History."* By Hilaire Belloc. Pp. x + 43. (London: Sheed and Ward, 1926.) Paper, 7*d*.; cloth, 1*s*.

QUITE a dozen years ago statements began to appear in our public press announcing that "Darwinism was dead," and so often has this assertion been repeated in more recent days that there has arisen in the public mind a fear that some sort of fatality has overtaken the reputation of the great naturalist. If by Darwinism is implied the body of fact, inference, and doctrine contained between the covers of "The Origin of Species," then assuredly Darwinism is not dead, for the revolution which that book began to work in the minds of thoughtful men sixty-seven years ago still continues its forward and unchecked progress.

The essence of Darwin's teaching is to be found in the last paragraph of the introduction he wrote for the first edition of "The Origin," and is repeated in all the later editions. There Darwin states that "I can entertain no doubt, after the most deliberate study and dispassionate judgment of which I am capable, that the view which most naturalists until recently entertained, and which I formerly entertained—namely, that each species has been independently created—is erroneous." Through Darwin's influence 'special creationists' in all the leading nations of the world were transformed into 'evolutionists.' Thus in its widest sense Darwinism implies merely the acceptance of the belief that all living things have been evolved from other and older living things. There is no book which seems so certain of a place in the permanent literature of the world as Darwin's "Origin of Species."

That Mr. H. G. Wells, trained under Huxley, should be a Darwinist in this wider sense occasions no surprise; but it was scarcely to be expected that Mr. Belloc, a devout son of the Roman Catholic Church, should be of the number. Yet, like Darwin, Mr. Belloc rejects special creation and accepts evolution; he even reproves Mr. Wells for being ignorant of the fact that "the conception of the Old Testament as an exact text-book of history and science, not a word of which must be taken as allegory or generalisation, was mainly confined to England and to her colonies. The Catholic Church never held it or could of its nature hold it" ("A Companion," p. 32). Mr. Belloc assures his readers that the theory of evolution is old, and that "the ancients and fathers of the Church" were familiar with it.

Darwinism is confined by many people to cover merely the theory enunciated in the "Descent of Man." When used in this more limited sense Darwinism cannot be considered as dead, for I do not know of any living anthropologist or student of the human body who believes that man arose by a special act of creation. Anthropologists may differ as to the kind of ape from which humanity has been evolved, and as to the geological date at which its face was turned man-wards, but on the evidence now before them, which grows in volume and in trustworthiness every year, most of our authorities share Darwin's belief that the anthropoid apes and man have sprung from a common stem. In this narrower sense Mr. Wells is a Darwinist, but so adroitly does Mr. Belloc cover his verbal tracks with a smoke-screen that it is somewhat difficult for his readers to decide whether as regards man's origin he is a fundamentalist or a Darwinist. He quotes with approbation the belief held by "St. Thomas, the great teacher of the Middle Ages," to the effect that "the creation of man was not mediate but direct." St. Thomas must, on this evidence, be classed among the fundamentalists. Mr. Belloc, however, gives his verbal assent to this narrower form of Darwinism which the fundamentalists find so objectionable; he believes in evolution; he regards the process by which man reached his present estate as open to debate; he speaks of "the moment when a true man existed at all"; he directs Mr. Wells's attention to the fact that certain tests show a close blood affinity between man and anthropoid. With such evidence before us we cannot say that Darwinism—even in this narrow sense—is dead.

Yet in justice to Mr. Belloc it should be added here that he rejects two points in Darwin's theory of man's origin. Darwin believed that man's rise from apedom was a slow and gradual process, and he hoped that the evolutionary forces which had lifted him thus high might lift him still higher. Mr. Belloc, on the other hand, prefers to believe that man's emergence was of the nature of a leap, and that he is now and will ever remain a 'fixed type.' Our scanty knowledge of fossil ape and man, and our much fuller information regarding their embryological histories, are altogether against Mr. Belloc's beliefs and in favour of Darwin's postulates, which have been rightly adopted by Mr. Wells.

There is a third and more restricted sense in which the term Darwinism is used. As an intrinsic part of the machinery which he regarded as being concerned in the evolution of living forms, Darwin introduced the principle or law of "Natural Selection," which he defined thus: "This *preservation* of favourable individual differences and variations, and the destruction of those which are injurious, I have called Natural Selection or the Survival of the Fittest" ("The Origin of Species," sixth edition, p. 63). There can be no doubt that Darwin claimed the recognition of this law and its application to the problems of evolution as his particular discovery. "Natural Selection," writes Mr. Belloc, "is the only thing that properly can be called Darwinism," and he reproves Mr. Wells for being unaware that Darwinism in this sense has been "riddled for a generation"; that it is "done for"; that it is "shaky"; that it is "nonsense"; that it is "old and exploded"; that it is "moribund"; and also that it is "quite dead."

Mr. Belloc devotes many pages to the exposition of Darwin's law of selection, and so little is the resemblance of the exposition to the original that one is forced to the conclusion that he has never read even the first chapter of "The Origin of Species." Darwinism as expounded by Mr. Belloc is certainly dead; indeed, it was never born. One does expect a historian, especially one who is ever accusing his antagonist—very unjustly—of being ignorant of recent events in the history of Darwinism, to be familiar with some of the chief happenings which followed the publication of "The Origin of Species." Mr. Belloc apparently does not know that Mr. St. George Mivart ("On the Genesis of Species," 1871), a convert to the Catholic Church, and one of the ablest anatomists of his time, formulated all the arguments which he now brings against Darwinism, and based them on an expert and first-hand knowledge of living things, such as Mr. Belloc can lay no claim to. Nor is he aware that Darwin, patient with even unscrupulous and prejudiced opponents, devoted twenty-eight pages of the sixth edition of "The Origin of Species" (1872) (pp. 176-204) to answering Mivart's criticisms. From first page to last of this sixth edition, Darwin protests against those early critics who supposed that the variations utilised by natural selection occurred 'singly' and 'accidentally'; he admits time after time that although he does not know the 'efficient cause' which brings variations into existence, yet he is certain that their appearance is regulated by many laws, "some few of which can be dimly seen," one of these being the law of 'correlated growth' whereby a whole series of structures may be modified together so as to serve more advantageously some functional purpose.

Mr. Belloc resuscitates this ancient misrepresentation of 'accidental' and 'single' variations and is thereby enabled, sitting in his armchair, unoppressed by any sense of modesty or burden of knowledge, to enumerate a dozen arguments, each ticked off after another with a triumphant emphasis, all of them demonstrating that the author of natural selection was an uncommonly stupid man and his modern critic a very clever fellow. One who presumes to criticise Darwin's "Origin of Species," especially from a mathematical point of view, should have known that Prof. Fleeming Jenkin ("The Origin of Species," sixth edition, 1872, p. 71), in 1867, had demonstrated the impossibility of a new breed or variety arising by natural selection if it had only 'accidental' variations to work upon, and that Darwin had shown this erudite professor wherein his error lay. Mr. Belloc knows nothing of this. Nor does he seem to be in touch with what is happening all around him now. It is difficult to believe that any one who sees the unceasing struggle which goes on everywhere and every year for the possession of the continents of the world and has been waged since the dawn of history, a struggle which is attended by the spread and domination of a few favoured races and the retrocession and obliteration of many less favoured races, can doubt the potency of Darwin's law of selection as a factor in the process of evolution. We may not like the way in which evolution works out its effects, but I do not think man, devise as he may, can escape from them. Certainly animals and plants in a state of Nature cannot.

In the five and fifty years which have elapsed since the sixth and last edition of "The Origin of Species" was published, we have learned much concerning how evolutionary processes work in the world of living things, much that was unknown to Darwin. We know now something of the complex laws of heredity, and of the physiological means whereby the growth of the body is regulated, so that its several parts are modified together and made to serve a functional purpose. An example mentioned by Mr. Belloc ("The Companion," p. 22) will serve to illustrate the direction in which our knowledge has improved. After citing one of Darwin's early critics to prove that "chance-made variations" could never have provided functionally useful structures, he proceeds thus: "And another biologist has well said—What is the survival value of horns without the structure to support them and muscles to use them?" Having set down this question, Mr. Belloc proceeds to answer it. "The mathematical chances," he informs his readers, "are millions and millions to one" against "the possibility of such a thing. Grant Design moulding all nature—that is, God—and this process is explicable." The impious biologist of to-day does not find it necessary to call in any divine or supernatural power to explain the multitude of changes which accompany the growth of horns in a young bull or antlers in a stag; the deity Mr. Belloc appeals to lies in the testes of these animals! The biologist knows that if a certain substance or hormone formed in the testes is withheld, none of these changes take place; if they are permitted to enter the circulation, then as the horns grow the bones and muscles of the neck increase in size and strength, the lumina of blood-vessels expand, and, what is still more wonderful, the temperament of the animal is transformed. The discovery of hormones, if it renders a direct appeal to the Almighty no longer necessary, does not in any way invalidate or lessen the efficiency of Darwin's law of natural selection; the hormone theory simply helps us to explain how variations of an adaptative nature can and do arise.

What is here written will suffice to show that Darwinism, in whatever sense we construe it, is neither an exploded creed nor a dead doctrine, and that those who assert the contrary not only sin against the light of truth, but also commit a crime by poisoning the springs from which a trusting public drinks its information.

It would be unfair to the memory of St. George Mivart were I to conclude without indicating, however briefly, the remarkable manner in which he anticipated in 1871 ("The Genesis of Species") the arguments which Mr. Belloc has brought against Darwin in 1926. Mr. Mivart began by asserting that a belief in evolution "was perfectly consistent with the strictest and most orthodox Christian theology"; Mr. Belloc echoes this statement but substitutes 'Catholic' for 'Christian.' Mr. Mivart called the "Fathers and Ancients" as witnesses for the orthodoxy of the theory of evolution, singling out St. Thomas for special mention; so does Mr. Belloc. Mr. Mivart reproved Darwin for his total ignorance of the "philosophy and teaching of the Catholic Church"; Mr. Belloc scolds Mr. Wells for the same offence. Mr. Mivart believed that structural modifications of a really useful kind were wrought by a supernatural agency; so does Mr. Belloc. Mr. Mivart believed that by a miraculous intervention man became possessed of a soul only in the last stage of his evolutionary progress; this apparently is also Mr. Belloc's belief. Darwin, as I have already mentioned, took infinite pains to answer Mr. Mivart's scientific objections, and I thought every one knew that Huxley had answered his theological arguments in a famous essay ("Mr. Darwin's Critics," 1871, Huxley's "Collected Essays," vol. 2, p. 120), but it must have escaped Mr. Belloc's attention, for he never alludes to it. Yet it is an essay which he might read with advantage, as should every one who honestly tries to reconcile Catholic beliefs with the truth of science. Even Mr. Mivart, in the end, found a reconciliation impossible. His later books were placed on the *Index Librorum Prohibitorum*, and in January 1900, when his last illness was upon him, he was excommunicated by Cardinal Vaughan because he dared to assert what his investigations into science had taught him. Such was Mr. Mivart's fate, and one wonders what would have happened to the author of "The Origin of Species" if his life had fallen in Catholic places and had his beliefs been in the keeping of Rome.

Arthur Keith.

New Quantum Theories.

Probleme der Atomdynamik. Erster Teil: *Die Struktur des Atoms*; Zweiter Teil: *Die Gittertheorie des festen Zustandes.* Dreissig Vorlesungen, gehalten im Wintersemester, 1925–26, am Massachusetts Institute of Technology. Von Prof. Max Born. Pp. xiii + 183. (Berlin: Julius Springer, 1926.) 10·50 gold marks.

CLASSICAL electrodynamic theory has had considerable success in explaining many of the phenomena of atomic physics, but there are other facts which seem to necessitate a radical departure from this theory. During the first quarter of the century many attempts were made to meet these difficulties by means of special assumptions and rules, which constituted the quantum theory. Although these methods have had remarkable success in the interpretation of a restricted region, it has long been felt that such a procedure, designedly adopted with a particular end in view, was not satisfactory and that a more general theory was required.

In 1925 Heisenberg put forward a new theory of quantum mechanics which seems likely to have far-reaching consequences, even if it does not lead to a complete solution of the problem. One of the fundamental ideas employed by Heisenberg is that only such things as are directly open to observation should enter into the mathematical formulation. He considered it advantageous to avoid every notion which cannot be connected with experiment, and so eliminated all ideas of motion within the atom. We are unable to assign to an electron a special position in space at a special instant of time, so that, so far as our observations are concerned, an electron orbit does not exist. In the mathematical statement of the new theory, developed in association with Born and Jordan, the continuous variables of the classical theory are replaced by systems of discrete quantities (matrices) which can be expressed by means of algebraic equations.

Although the theory of matrices is founded on the work of Cayley, Sylvester, and H. J. Smith, and is about seventy years old, some mathematicians and most physicists are unfamiliar with the ideas involved. As pointed out recently in these columns (NATURE, August 28, 1926, vol. 118, p. 295), the fundamental notion is by no means difficult to grasp. Cayley considered a square arrangement of numbers as constituting a matrix, realising the value of treating it as a single magnitude. Thus nine numbers put in square formation, three by three, are called a matrix of order three. For example:

$$\begin{bmatrix} 1, & 2, & 3 \\ 4, & 5, & 6 \\ 7, & 8, & 9 \end{bmatrix}$$

We may also deal with a rectangular matrix of mn numbers, arranged in m rows and n columns. The matrix is to be thought of as a *compound* unit, an assemblage of numbers arranged in order but constituting a single entity. A simple geometrical illustration is afforded by taking $[x, y]$ as specifying the position of a point in a plane. Unless $x = y$, the point $[x, y]$ is not the same as the point $[y, x]$. Such an entity, which may include a row of n numbers, is a special case of a matrix of rank one. The determinant of a matrix must be distinguished from the matrix itself, just as the area of a triangle must be distinguished from the triangle itself. Cayley gave rules for adding, subtracting, and multiplying matrices, and it is of importance in the present connexion that the product AB of two matrices A and B is not generally equal to the product BA.

The most interesting part of the volume under notice is undoubtedly that in which Prof. Max Born has described in some fifty pages the development of the new quantum mechanics. In the classical theory a particular co-ordinate may be represented by a Fourier series comprising the various components, but in the new theory the collection of all possible vibrations is to be regarded as a whole in a quadratic scheme forming an infinite matrix. If q denote such a co-ordinate matrix and p an impulse matrix, instead of assuming that the product qp is equal to the product pq, we must introduce a new postulate, namely,

$$pq - qp = h/(2\pi i),$$

where h is Planck's constant and i is the square root of -1.

P. A. M. Dirac of Cambridge has expressed the new theory in a different form by means of a specially devised quantum algebra in which the quantum variables satisfy all the ordinary laws of algebra, excluding the commutative law of multiplication. Instead a special quantum condition is postulated, involving Planck's constant and equivalent to that stated above.

Schrödinger starts from the idea suggested by de Broglie that an atomic system is not to be represented by a trajectory, that is, by a point moving through the co-ordinate space, but must be represented by a wave in this space. From this starting-point he develops a wave-theory of matter, and obtains from a variation principle a differential equation which the wave function must satisfy. This equation turns out to be closely connected with the Hamiltonian dynamical equation which specifies the system. When the general solution of this equation is known, matrices to represent the canonical variables may easily be obtained satisfying all the conditions that they have to satisfy according to Heisenberg's matrix mechanics. The mathematical equivalence of the theories is thus established, and it is shown that (in the words of Schrödinger) "the wave-mechanics and the matrix mechanics are mathematically identical." The concept of characteristic oscillations in the atom and Schrödinger's theory based upon it represent a most significant contribution to the development of the quantum theory. "From the formal mathematical point of view it includes the whole of the Heisenberg-Born-Dirac matrix theory, and gives, moreover, a simplified, practically convenient method of finding the matrices. Beyond this, it opens new avenues of thought and seems to afford our first glimpse of the true nature of the quanta" (Epstein).

The development of the new theory is taking place with great rapidity, and several applications have already proved successful; only a few of these can be mentioned here. Pauli has shown that the Balmer formula for the hydrogen spectrum can be accounted for quantitatively, as well as the influence of electric and magnetic fields on this spectrum. A theory of the Stark effect based on Schrödinger's ideas has been presented by Epstein, who considers the radiation from a hydrogen-like atom in an electric field. The calculated positions of the components of the spectral lines practically coincide with those obtained in Epstein's old theory, which gave excellent agreement with experiment. The main interest lies in the expressions for the intensities, which agree with the observed values better than those deduced by Kramers from the correspondence principle. Schrödinger himself has discussed the same problem. Brillouin has treated the subject of rotation spectra by the calculus of matrices and has found experimental verification for certain of the theoretical deductions. Dirac has discussed the extension of the theory to relativity mechanics, and in particular to the theory of Compton scattering, and obtained results which can be tested by experiment.

One test of a scientific theory is its comprehensiveness, and the wide sweep of the new quantum mechanics is shown not only in the various ways of formulating it in mathematical language, but also in the physical ideas that may be associated with it. It is probable that the views of the quantum suggested by E. T. Whittaker and by the present writer, in which its magnetic aspects are emphasised, may be simply related to the new theory. In a recent paper Whittaker has described a simple light quantum in which a disembodied magnetic molecule, travelling with the speed of light, forms a singularity on the wave front and confers upon it the desired quantum properties. It may be suggested that such a quantum is related to a quantum magnetic tube on one hand, and to Schrodinger's wave mechanics on the other.

In discussing the relation between the quantum theory and the classical laws, Dirac remarks that the new theory "suggests that it is not the equations of classical mechanics that are in any way at fault, but that the mathematical operations by which physical results are deduced from them require modification. *All* the information supplied by the classical theory can thus be made use of in the new theory."

H. S. Allen.

Our Bookshelf.

A Text-Book of Organic Chemistry: Historical, Structural and Economic. By Prof. John Read. (Bell's Natural Science Series.) Pp. xii + 680. (London: G. Bell and Sons, Ltd., 1926.) 12*s.* 6*d.* net.

Owing to the fact that systematic organic chemistry is but rarely taught in our public and secondary schools, elementary text-books on the subject are far less numerous than books on the inorganic branch. We have, it is true, a few excellent introductions to organic chemistry, but there is still room for a few more, especially if, like the present work, they are written in an agreeable style, are accurate, do not intimidate the beginner with a vast mass of unrelated facts, and, above all, show traces of original treatment.

Prof. Read departs from precedent by prefacing the subject with a fifty-page sketch of the development of chemistry as a whole, and although one might urge that much of this matter is not strictly relevant, the innovation is nevertheless welcome, not only because it is well done, but also because this phase of chemistry needs more emphasis than it has been given in the past. Another useful feature of the book is the insertion of references to industry and economics, which, as the author states, undoubtedly stimulate and maintain the interest of students. In this connexion, however, it is important that the statements and figures should be as up-to-date as possible, and that the period of time to which they relate should be precisely stated.

In the book under notice one would expect to, but does not, find adequate references to such recent and important matters as the large-scale manufacture of urea, cellulose-nitrate varnishes, acetic acid from cellulose by anaerobic fermentation, insulin, and the 'berginisation' of coal. Further, wholesale prices are far more important than those charged by the retailer, and when we read (p. 314) that "commercial oxalic acid costs about 10*d.* per lb., and the purified substance about 1*s.* 6*d.* retail," we can but marvel at the patience of the small consumer, because for a long time past the market price of the 98-100 per cent. commodity has been less than 6*d.* a pound, and now it is less than 4*d.*

Prof. Read and his publishers deserve our thanks for producing a thoroughly sound and interesting work.

The Modern Soap and Detergent Industry, including Glycerol Manufacture. By Dr. Geoffrey Martin. In 3 vols. Vol. 3: *The Manufacture of Glycerol.* (Containing the Index to the Complete Work.) Pp. xi + 78 + 36 + 13 + 20 + 8 + 41 + 57. (London: Crosby Lockwood and Son, 1926.) 30*s.* net.

The working up of the by-product, glycerol, of the soap and stearin candle industry is of such economic importance that the author has felt justified in allotting this entire volume to the subject of glycerol. In attempting to prepare a complete treatise (as the present volume claims to be) on any branch of chemical industry, great difficulties confront the writer. Many books of such a type, while apparently satisfactory to the technological student, are often to the works' chemist of less value and perhaps incomplete. This is mainly due to the unwillingness of manufacturers (very often for good reasons) to divulge details of processes which may be of indirect help to rival firms.

In the work under review it may justly be claimed that the author has collected together a great many practical details of modern glycerol plants and processes, especially in the sections dealing with the working of evaporators and stills. In fact, in no similar single publication, at least in English, can such a mine of useful information be obtained. The author has been extremely fortunate in having secured the valuable aid of various industrial firms, including still-makers, in the compilation of his data. In addition, as in the previous two volumes of this series, references are given to practically all the important related patents, including even those at present of no industrial significance, on the subject of glycerol production and application. A useful section on polymerised glycerol and glycerol substitutes is also included. In the final section the commercial valuation and analysis of glycerol and the various specifications for products of different grades are treated in a very satisfactory manner.

An exhaustive index for the three volumes is also included in the present work, with cross references. The complete work forms an indispensable reference treatise on the technical literature of the soap and delegent industry.

J. REILLY.

Practical Ultra-Violet Light Therapy: a Handbook for the Use of Medical Practitioners. By T. Clyde McKenzie and A. A. King. Pp. 108 + 14 plates. (London: Ernest Benn, Ltd., 1926.) 6*s*. net.

THIS handbook is for the use of medical practitioners; it contains a foreword by Sir John Robertson, the Medical Officer of Health for Birmingham, who is keenly alive to the part which this form of therapy is playing and is likely to play in the near future.

Doctors have now to know something of the technique of the sources of ultra-violet radiation, of the effects to which the rays give rise, and of the diseases which are favourably influenced thereby. The book under notice, in a restricted sense, provides this information; the authors write practically only upon their own experiences, and these appear to be restricted to the use of the mercury vapour lamp. They give an excellent account of these lamps, of the way in which they should be used, and of the diseases for which their use is warranted. We can understand, however, that many medical practitioners will want to know something about the open arcs which are largely used in many of the big light clinics.

Dosage in this form of therapy is still rather primitive; the 'normal dose' according to the authors may be taken to be "that which will produce in the patients' most sensitive skin surface the faintest perceptible erythema."

No doubt in time there will be established a physical unit of ultra-violet radiation which will be of service in medicine, and it is to be hoped that the interval will not be so prolonged as has been the case in X-ray therapy.

The American Annual of Photography, 1927. Vol. 41. Edited by Frank R. Fraprie and E. J. Wall. Pp. 238 + 54. (Boston, Mass.: American Photographic Publishing Co.; London: B. T. Batsford, Ltd., 1926.) 1.50 dollars.

THIS well-known annual appears this year in a new form with a much larger page, which gives more scope for the considerable number of half-tone reproductions with which it is embellished. The text also is improved, for the articles are fewer, longer, and of more interest; and the developer formulæ are set out in a more businesslike and concise form than we have been accustomed to, a strictly comparative table for each type of developer being given on the basis of 1000 parts of water in every case. Mr. E. J. Wall gives a practical digest of the year's work in photography, which is fuller than such summaries generally are, including working formulæ in almost all cases, and with occasional valuable comments. Mr. Wall also contributes a historical article on the desensitising of plates, written with his usual thoroughness. Among the other articles of special scientific value is one by Dr. Wightman on "Photographic Sensitivity and the Latent Image," and one by Messrs. J. I. Crabtree and J. F. Ross on "The Recovery of Silver from Exhausted Fixing Baths." All these contributions mentioned have full references to the original sources of information appended to them, forming valuable bibliographies of the subjects.

An Almanack for the Year of Our Lord 1927: containing an Account of the Astronomical and other Phenomena, and a Vast Amount of Information respecting the Government, Finances, Population, Commerce and General Statistics of the various Nations of the World. By Joseph Whitaker. Complete edition. Pp. lvi + 896 + lvii-clxxxiii. 6*s*. net. Abridged edition. Pp. xlviii + 240 + lvii-clxxxv. Paper, 1*s*. 6*d*. net. (London: J. Whitaker and Sons, Ltd., 1927.)

THE new edition of 'Whitaker' has undergone some rearrangement and contains several new features, but its familiar appearance and convenient form remain unchanged. Among the new features are fifty-seven short articles dealing with questions of the day so varied as betting, Kent coalfields, polar flights, and war debts; a summary of science and invention, art, music, and the drama during the year, and details of meteorological conditions in June, July, August, and September for half a century. The statistical information about all states of the world is given as usual. The 'abridged edition' now takes the place of the 'popular edition,' which is discontinued. It contains not a selection but an abridgment of the contents of the larger volume, and is a marvel of value at the price.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Beginning of Agriculture.

AT the present moment there is a widespread misunderstanding of the nature of the evidence that is now available to suggest how, when, and where the practice of tilling the soil began. It is not my intention to traverse the whole field so fully explored in 1921 by Prof. Thomas Cherry in his address on "The Discovery of Agriculture," delivered at a meeting of the Australian Association for the Advancement of Science; but new information is now available that confirms the accuracy of his statement, which should dispel the doubts and difficulties that have arisen.

I suppose most people would be prepared to admit that the invention of agriculture was the beginning of civilisation. It involved a really settled society and the assurance of a food supply. Hence it created the two conditions without which there could have been no real development of arts and crafts and the customs of an organised form of society. But for many years there has been a sharp conflict of opinion as to how and where this momentous event took place.

In 1901 it was my good fortune to become associated with Profs. George A. Reisner and Albert M. Lythgoe in the most thorough study of an early pre-dynastic site (Naga-ed-Der in Upper Egypt) that has ever been made. In the course of examining the well-preserved bodies found in this cemetery, I recovered from the alimentary canals of a large number of bodies the food which these people had consumed about sixty centuries ago. This material I sent for examination to Dr. Fritz Netolitzky, the professor of pharmacology in the University of Czernowitz, who is the leading authority on the subject. Prof. Netolitzky published an account of the results in the *Zeitschrift fur Untersuchung der Nahrungs- und Genussmittel* (1911, Bd. 21, p. 607) and *Die Umschau* (1911, pp. 45 and 95). At the same time he sent me a letter summarising his results, which I quoted in the little book, "The Ancient Egyptians," I was then engaged in writing.

The statement that barley was the staple article of diet in Egypt from the earliest pre-dynastic period has passed without any notice whatever during the last fifteen years, excepting the use made of it by Prof. Thomas Cherry. In recent discussions that have been taking place at the meetings of the British Association, the Royal Anthropological Institute and elsewhere, as to the beginning of agriculture in Egypt, I am told that no reference of any sort has been made to these fundamental facts, the neglect of which must necessarily sterilise any real investigation of this most important issue.

Dr. M. Gompertz has directed my attention to a fact (which I had not realised until then) that in his memoirs published in 1911, Prof. Netolitzky has not made any unequivocal statement on the barley question. In fact, the only place in which the issue is explicitly mentioned is his memoir in *Die Umschau* (1911), which is almost identical with the private letter its author sent to me in the same year. But there is an important difference between the letter and the published statement. In the latter the statement is made that in almost every sample of the early pre-dynastic Egyptians' food, which I sent to Dr. Netolitzky, there is evidence of the husks of "the barley-wheat-type" (Gersten-Weizentypus), whereas in Dr. Netolitzky's private letter the corresponding sentence ran "in almost every sample there was evidence of the husks of barley." The difference between these two statements was so vital that I wrote to Prof. Netolitzky and asked him for further information. In a letter dated Nov. 25, 1926, he says:

"Barley is the chief cereal found in the Naga-ed-Der specimens. I am of the opinion that wheat was not eaten at that time, for we certainly should have found it if it was present in the specimens, because we can detect the much softer fragments of the husks of barley where the much harder and more characteristic husks of wheat are completely lacking. We can therefore assume that the Naga-ed-Der people did not use wheat; at any rate it is absent in the numerous specimens that you sent me. Some years ago the late Dr. Bruijning, of the Agricultural Experimental Station at Wageningen, wrote to me to say that he had come to the conclusion that wheat first came into Egypt at the beginning of the dynastic period. Schulz ('Die Geschichte der kultivierten Pflanzen,' 1, 1913) expresses the conclusion that barley was the first cereal used in the Nile Valley."

Prof. Netolitzky has also been kind enough to send me a paper by Frau Hedwig Gherasim ("Neue Kennzeichen der Getreidespeizen und Beitrage zur Bestimmung prähistorischer Pflanzenfunde," *Pharmaz. Monatsheften*, 1921) which contains the following statements. She says that while Prof. Netolitzky was convinced barley was the chief cereal used by the pre-dynastic Egyptians, at the time she began her research he had not definitely excluded the possibility—his letter to me in 1911 shows it to have been only a possibility—that wheat might also have been used, because in the material from Naga-ed-Der there was a number of husks of indefinite type (his barley-wheat-type). The solution of this problem he postponed for further investigation and then entrusted the task to Frau Gherasim, who says that she has now examined Prof. Netolitzky's material and has been unable to find a single case in which the diagnosis of wheat can be established, whereas there is ample evidence that barley was present in most of the specimens she examined. She says this discovery is of extraordinary interest and importance, for it definitely establishes the fact that the pre-dynastic people did not eat wheat. The number of specimens is so great that such an assertion can be made with complete confidence. The earliest example of *Triticum dicoccum* appears to be that found by Borchardt in the foundation at the west end of the offering-granary in the temple of King Sahure of the fifth dynasty. Dr. Cherry and others have pointed out, however, that it may have been in use in earlier dynastic times.

The question of the cultivation of barley in Egypt is not merely a matter of local interest, but also involves the much wider problem of the origin of civilisation itself. During recent years there have been repeated discussions as to the relative antiquity of Sumerian and Egyptian civilisation. Prof. Breasted now tells us that this question has been definitely settled once for all. In his book, "The Conquest of Civilisation," which was published a few weeks ago, he makes this statement (p. ix): "Perhaps the most far-reaching consequences among newly-discovered sources are the new cuneiform tablets with [Sumerian] dynastic lists at last determining the maximum age of the earliest Babylonian written documents. They are at most a little earlier than 3000 B.C. Thus it is now a finally established fact that civilisation first arose in Egypt, followed a few centuries later by Babylonia." The opinion he expresses agrees with that of most of the experts of Great Britain, Europe and America who have first-hand knowledge of the material found within recent years in Mesopotamia.

It is now generally admitted that the first dynasty of Ur can be dated at 2900 B.C., and that the most remote age that can be assigned to it is 3100 B.C. Painted pottery has been found in Susa [Elam] which may be, and probably is, earlier than the first dynasty of Ur; but this has been equated with the pottery distinguished as Susa II. This follows Susa I., which it is generally estimated corresponds to the middle pre-dynastic period in Egypt. In other words, in Egypt the whole duration of the early pre-dynastic period is definitely anterior to any evidences of civilisation that have been found in Asia or in fact anywhere in the world. If, then, the early pre-dynastic evidence reveals the presence of cereals and suggests that agriculture was then being practised, we have positive evidence of the most significant kind that civilisation began in Egypt. We know also that people in Egypt at this time, many centuries before the metal copper was known, were using the copper ore malachite, which there is every reason for believing was obtained from the Wady Alaqi in Nubia. These and scores of other facts to which I have been constantly directing attention, in season and out of season, during the last fifteen years, establish on a firm foundation the certainty that civilisation, not merely agriculture and the working of metals, but also the invention of all the essential arts and crafts, customs and beliefs that go to the making of early civilisation, were first invented in the Nile Valley.

The fact that the alimentary canals of all those earliest Egyptians contained barley is surely certain evidence that barley was growing in Egypt at that time. Whether it was indigenous or not we have of course no direct evidence to prove, because every foot of land that can be cultivated in the Nile Valley has been turned over countless millions of times during the last sixty centuries by an unbroken series of *fellahin*. But the fact that wild barley is found in the north-east corner of Africa, both on the Mediterranean littoral and in the regions to the south and east of Egypt, suggests that it was also growing in the Nile Valley when men first made their way into that strip of land.

The only alternative is to assume that the earliest Egyptians brought barley into the country with them. I need scarcely say that this is a mere speculation, in support of which there is no evidence of any sort, not even a suggestion of its likelihood. The conclusion that is forced upon us is that the earliest settlers in the Nile Valley found barley growing there in a wild state and made use of this natural food supply. Living under such ideal conditions, the population, in course of time, increased to such an extent that the natural supply was inadequate to support them. Then it can be assumed men imitated the natural processes which they had watched year by year for unknown centuries, and by extending the area of irrigation instantly devised the art of irrigation and the invention of agriculture. This is the only reasonable interpretation of a vast mass of evidence.

G. ELLIOT SMITH.

University College, London,
Dec. 1.

Wireless Communication and Terrestrial Magnetism.

THE letters which have recently appeared in NATURE on the relationships of wireless reception and terrestrial magnetism suggest that a few remarks from the point of view of a magnetician may not be superfluous. First, on an historical point, it should be remembered that estimates of the altitude of a stratum of high electrical conductivity were made long before the times of wireless communication. Cavendish (*Scientific Papers*, vol. 2, p. 233) in 1790 obtained on strictly scientific grounds an estimate of from 84 to 114 km. for the altitude of an auroral arc. Prof. Stormer's methods of high precision have supplied numerous results for the lower level of aurora, which have long been well known. The levels he has found show variations with similar limits to those recently obtained by Appleton and Barnett (*Roy. Soc. Proc.*, A, vol. 113, p. 450). Auroral observations, of course, are not possible by day, and we may hope to learn much from wireless which it might be difficult or impossible to derive from auroral observations.

Again, the continual existence of high electrical conductivity in the upper atmosphere was first advanced as an hypothesis neither by Heaviside nor by Kennelly, but by Balfour Stewart. His statement will be found in §§ 121 and 134 of his article on "Terrestrial Magnetism" in the ninth edition (epoch *circa* 1882) of the "Encyclopædia Britannica." Stormer has shown that on special occasions aurora may extend to heights exceeding 600 km. Thus the term 'layer' applied to the space of high conductivity may not be a very appropriate one. But if any name is to be associated with a 'conducting layer' in the upper atmosphere, it should surely be neither Heaviside's nor Kennelly's, but Balfour Stewart's.

The arguments for the existence of the 'conducting layer' on the side of terrestrial magnetism, even leaving aurora out of account, are by no means wholly theoretical. The strongest argument, in the opinion of the writer, is derived from the observed large universal increase of the diurnal variation of the magnetic elements as we pass from sunspot minimum to sunspot maximum. No such universal relationship has been observed in any meteorological or other element at the earth's surface, or in the lower atmosphere, except in the case of electrical earth currents, and these are generally believed, through their association with aurora, to be a direct consequence of the electrical currents overhead.

It is this argument that has led practically all, if not all magneticians, to accept the upper atmosphere as the seat of electrical currents to which the regular diurnal variation of the magnetic elements is due. It is important to notice that it is the regular diurnal variation that has been observed to hold a parallel course to sunspot frequency. Speaking generally, years of few sunspots are less disturbed magnetically than years of many spots, but a year of many spots may not be a highly disturbed year. Thus 1893, though a year of sunspot maximum, was much quieter than either 1892 or 1894.

All the magnetic elements show largely increased diurnal ranges in years of many sunspots. In Britain the increase seems larger for H (horizontal force) than for D (declination). In H an increase of 100 in Wolf's sunspot frequency has corresponded to a rise of about 100 per cent. in the range of the mean diurnal inequality for the year. The effect varies with the season of the year, the percentage rise in the range at Kew being roughly twice as great at midwinter as at midsummer. With increasing sunspot frequency, the tendency seems to be for the increase of amplitude to be larger in the 24-hour Fourier wave than in the waves of shorter period. This implies in the average day a reduction in the difference between day and night.

There is an important difference in Europe between quiet and disturbed days. On quiet days the magnetic changes are much larger in the day than in the night hours; but during large disturbance the night hours are the most active. Large disturbance in Europe is much more common between 4 P.M. and 4 A.M. than between 4 A.M. and 4 P.M.; it is rare near 10 A.M. This difference between night and day is not, however, universal all over the earth. In the Antarctic, from 1911 to 1913, disturbance was much more in evidence during the day than the night hours. The distribution of magnetic disturbance throughout the 24 hours in high northern latitudes still apparently awaits investigation.

Another result of interest is that the regular diurnal variation, whether in years of many or of few sunspots, tends to be larger on disturbed than on quiet days. This seems to imply that in addition to local irregularities in the conductivity of the 'conducting layer,' due presumably to the irregular distribution of the sources of ionisation, there is during magnetic disturbance a decided increase in the average conductivity. This phenomenon is comparatively trifling in southern England, but increases in prominence as we go north. If we may judge from what happened in the Antarctic in 1911 to 1913, it is exceedingly prominent in high magnetic latitudes, at least in years of few sunspots. At Cape Denison, the base station of the Australasian Antarctic Expedition, the range of the regular diurnal variation of H in the midwinter months for an average international magnetic character of 1·05—which implies only very moderate disturbance—was nearly six times the range from the international quiet days. Magnetic disturbance in these high latitudes is much larger and more persistent than in central Europe. This suggests that the natural place to study the relationships between wireless and magnetic phenomena is not the south of England but the north of Scotland, or still more northern regions. There are now magnetic observatories at Lerwick, Sodankyla (Finland), Matochkin Shar (Novaya Zemblya), Godhavn (Western Greenland), Meanook (Canada), and Sitka (Alaska). Wireless observations at two or more of these stations ought to provide in a short time a lot of interesting material.

C. CHREE.

75 Church Road, Richmond, Surrey.

The Symmetrical Top in Wave Mechanics.

IN a recent issue of NATURE (Dec. 4, 1926, p. 805) there appeared a letter of Messrs. R. de L. Kronig and I. I. Rabi, in which they gave, on the basis of the new wave mechanics of Schrodinger, an expression for the energy of a symmetrical rotator, *i.e.* a rigid polyatomic molecule having two equal moments of inertia.

A like result has also been obtained by F. Reiche (*Zeit. f. Phys.*, 39, 444, 1926) using the wave mechanics. Furthermore, under the assumption that the molecule possesses a permanent electric moment along the direction of its figure axis, Reiche derived to first order approximation the addition to the energy expression caused by placing the molecule in an external electric field. Independently of Reiche, also using the wave mechanics, we have carried the calculation to the second order of approximation and have thus been able to compute the dielectric constant. We find for the total energy $W^*_{j,m,n}$ of the molecule in the presence of an electric field of strength F

$$W^*_{j,m,n} = W_{j,n} - \mu F\frac{mn}{j(j+1)} + \frac{(\mu F)^2}{h^2/8\pi^2 A}4(\Phi_{j,m,n} - \Phi_{j+1,m,n}),$$

where $W_{j,n}$ is the energy of the molecule without electric field, as already given by D. M. Dennison (*Phys. Rev.*, 28, 318, 1926) using the matrix mechanics. μ represents the permanent dipole-moment, A the moment of inertia about an axis perpendicular to the figure axis, and j, m, and n three quantum numbers. The first of these may take all positive integral values not including zero, while the others may take both positive and negative integral values including zero, subject to the restriction that the absolute value of each shall not exceed the value of j. The function $\Phi_{j,m,n}$ is a numerical factor depending only upon the quantum numbers:

$$\Phi_{j,m,n} = \frac{(j^2 - m^2)(j - n^2)}{(2j-1)(2j)^2(2j+1)},$$

$\Phi_{j+1,m,n}$ is the same expression, where only $j+1$ is substituted in place of j.

From the energy expression given above, the dielectric constant of a perfect gas is found to have the following value at high temperatures:

$$1 + \frac{4\pi}{3}\frac{N\mu^2}{KT},$$

where T is the absolute temperature, N the number of molecules per unit volume, and k the Boltzmann constant. This result is in complete agreement with the value of the dielectric constant of such molecules already found by Kronig (*Proc. U.S. Nat. Acad. Sci.*, 12, 608, 1926) using the matrix mechanics, and it means that at high temperatures the dielectric constant obeys the law of Langevin-Debye. We have found that at usual temperatures the departure from this law cannot exceed a few per cent.

It may be remarked that the second term in the energy expression given above predicts the existence of a Stark effect of the first order in the band spectra of symmetrical molecules, whereas for diatomic molecules an effect only of the second order is to be expected. The separation of the lines in the Stark effect of the first order for symmetrical molecules depends upon the magnitude of the dipole-moment and the field strength, but *not* upon the moments of inertia of the molecule. The intensity of the lines, on the other hand, is dependent upon the moments of inertia. The separation of the lines in the Stark effect of the band spectra of polyatomic molecules, which a simple calculation shows to be of a sufficient magnitude to be measured experimentally, thus provides a means of finding the dipole strength of such molecules. One finds $\Delta\lambda/\lambda = 22 \times 10^{-6}$ with $F = 50{,}000$ volts/cm. and $\mu = 1 \times 10^{-18}$ C.G.S. units.

A detailed paper covering the work outlined here will appear shortly by one of us in the *Physikalische Zeitschrift*.

P. DEBYE.
C. MANNEBACK.

Physikalisches Institut,
Eidgen. Technische Hochschule, Zürich,
Dec. 14.

The Homologues of the Adrenal or Suprarenal Bodies in Teleostean Fishes.

THE homologues of the adrenal or suprarenal bodies in teleostean fishes have long been the subject of discussion. In 1884, Weldon (*Quart. Jour. Micr. Sci.*, 1884, 24, 171-182) thought that the adrenals were frequently absent from this group, and that the lymphoid head-kidney took their place in these cases. This theory was refuted by one of us in 1896 (Swale Vincent, *Proc. Birm. Nat. Hist. and Phil. Soc.*, 10, Part 1, 1896). In the meantime it was commonly assumed that the pale, spherical bodies, near the caudal end of the kidney, on its ventral or dorsal surface, were the homologues of the adrenal bodies in higher vertebrates (Swale Vincent, *Trans. Zool. Soc. Lond.*, 14, Part 3, 1897). The corpuscles of Stannius, as these bodies were named, appeared, in fact, to have roughly the structure of the inter-renal of the elasmobranch, and the cortex of the adrenal of higher vertebrates.

In 1908, E. Giacomini (*R. Acad. delle Scienze dell' Instituto di Bologna*, 24 maggio, 1908) put forward another claimant for the position of teleostean adrenal cortex, namely, groups of glandular-looking cells in the lymphoid head-kidney, and stretched out along the blood vessels in this region. Since that time it has been customary to refer to the anterior and posterior cortical adrenals in these fishes.

The work of Giacomini seemed to minimise the importance of extirpation experiments carried out upon the corpuscles of Stannius, in which experiments eels were found to live indefinitely after extirpation of these bodies (Swale Vincent, *Proc. Roy. Soc. Lond.*, 62, 1897).

We have recently had occasion to study the microscopic structure of the corpuscles of Stannius and the 'anterior adrenal bodies' of Giacomini. Using approved modern histological methods, we are satisfied that we have to deal not with two isolated portions of the same structure or organ, but with two totally separate and distinct glands, having in all probability different functions. This is indicated by a striking difference in the general appearance of the sections and is confirmed by measurements of the various elements. There are also obvious microchemical differences in the two structures.

In examining the detailed cytology, we have received much assistance from Dr. C. da Fano, of King's College, London, who has made for us preparations to show the Golgi apparatus. He agrees with us that the two structures bear very little resemblance to each other and that the Golgi apparatus has a different arrangement in the two cases.

We are inclined to believe that it is the anterior adrenal body in the head-kidney which ought to be considered the homologue of the adrenal cortex; and, if this is correct, this body should be styled simply the adrenal cortical body. If this is so, what are we to say of the corpuscles of Stannius? Here is a perfectly definite circumscribed organ for which we have to find a place, both morphological and physiological. One is tempted to place it, provisionally, in the group of epithelial organs, in which are included the anterior pituitary, corpus luteum, the parathyroids, islets of Langerhans, etc. It has occurred to us that it may, in fact, be an insulin-producing tissue, and if sufficient material can be collected, it is our intention to test this. We hope to publish a full account of this work at a later date.

Swale Vincent.
F. R. Curtis.

Department of Physiology,
Middlesex Hospital Medical School,
London, W.1.

Scientific Achievement and Aptitude.

The excellent editorial in Nature of Nov. 13 suggests a few comments. Several years ago, Lady Gregory came to the University of Colorado and lectured on the Irish drama. She insisted on the importance of each country or region fostering its own dramatic art, and cultivating dramatic expression among its citizens. Under such conditions, she urged, not only is there a quickening of the general intelligence, but also genius finds its appropriate setting and chance for appreciation. Surely the same argument may be used with reference to science. It is not possible to determine the native ability of various nations from such statistics as are cited by Dr. Slosson. Very much depends on popular recognition, and even the discovery of new chemical elements is largely controlled by opportunity. Although the genius is an asset of incalculable value, he is only of value to communities intelligent enough to profit by his labours. In 1914, 105,681 infants under one year died in Great Britain. In 1924 the number was only 65,259. In the same period the deaths per thousand were cut down from 23·9 to 19·3. This was not done through the brilliant inspiration of some genius, but by the incessant labours of thousands of relatively or absolutely obscure persons using the knowledge communicated by scientific men of all grades of distinction.

My own interest in natural history was greatly stimulated by J. W. Taylor and W. D. Roebuck, who were preparing a "Monograph of the Land and Freshwater Molluscs of the British Isles." Their methods were in direct contrast to those of some monographers. We not rarely hear that so-and-so is monographing the ——. All specimens must be sent to him. No one else should have anything to say on the subject. By the time the great work appears, interest in its topic has so long been dead, that it is received with due reverence but little real joy. There are, of course, some fields of science which are necessarily cultivated in this manner. Only a few men of unusual training and powers, provided with unusual and costly apparatus, can do anything with them. The 'man in the street' is absolutely out of it, except as a possible contributor of funds. But in other fields this is not the case. Taylor and Roebuck, from the beginning, did everything to interest young conchologists in the possibilities of doing things, of making discoveries. The result was a great deal of enthusiasm and the accumulation of an enormous mass of data which eventually went into the monograph. It is lamentable to have to record that this beautifully illustrated and minutely detailed work has ceased publication, because the cost of printing is too high. As a contribution to national culture it would abundantly pay the country to continue the printing at the public expense.

The moral seems to be, that whether we desire material benefits or increased happiness, bread or song, it is of the utmost importance to cultivate scientific interest among the people at large. This interest should not simply take the form of open-mouthed astonishment at the works of the learned, but should be inspired by the hope and expectation of personal accomplishment, and the sense of having part in a great undertaking.

T. D. A. Cockerell.

University of Colorado,
Nov. 24.

Behaviour of Silicic Acid Gel during the Drying-up Process.

In the *Proceedings of the Indian Association for the Cultivation of Science* for June 1926, K. Krishnamurti in a short note describes the formation of fibres of potassium chloride when crystallised from silicic acid gel. This note was apparently written as the result of an observation made in May 1924.

On October 18, 1924, we communicated to the *Journal of Physical Chemistry* a paper, "Some

Observations on the Preparation and Properties of Silicic Acid Gel," which was published in March 1925. In this paper we describe the fibre-like crystals of sodium chloride obtained when crystallised from silicic acid gel. This publication seems to have perturbed Mr. Krishnamurti, since in his note of June 1926 he emphasises the fact that his *observation* was made prior to the date of the communication of our paper.

However, we decided to make no comment on Mr. Krishnamurti's remarks, knowing that our observations would receive such consideration from scientists as they deserved.

In a letter published in Nature of December 11, 1926, Mr. Krishnamurti accuses us of having overlooked his contribution in our more recent publications. In particular, he refers to our paper published in *Proc. Roy. Soc.*, A, vol. 112, p. 468, 1926, on "Change of Crystal Structure of some Salts when Crystallised from Silicic Acid Gel: The Structure of Silicic Acid Gel." Mr. Krishnamurti's remarks are incorrect, even assuming that his note merited mention in our published work. If he will take the trouble to refer to our paper in the *Proc. Roy. Soc.*, he will find that the paper was communicated on May 17, 1926, hence it would be impossible for us to include in that paper a reference to a paper which was not published until June 1926.

Mr. Krishnamurti will also be interested to learn that we gave a summary of our last paper before the Chemistry Section of the British Association at Southampton in September 1925.

For Mr. Krishnamurti's information only we beg to state that our first observation of the formation of needle-like crystals of sodium chloride from silicic acid gel was in November 1923, but of course this was not publicly recorded until we had completed our investigation of the problem in hand.

J. B. Firth.
H. A. Fells.

The Chemistry Department,
University College,
Nottingham, Dec. 13.

[Discussions of priority of observation or publication are of limited interest and tend to become purely questions of personal differences of opinion. We much prefer, therefore, not to give further space to such matters as are referred to in the above letter.—Ed. Nature.]

A Source for Resonance Radiation.

While engaged in some experiments on mercury resonance radiation at Johns Hopkins University last spring, I became convinced that a less erratic and, if possible, more intense source than the usual water-cooled quartz arc was almost a necessity for some kinds of work. A high-voltage discharge seemed likely to be much steadier than a low-voltage arc, and an obvious way of cutting down self-reversal due to normal mercury vapour was to use a gas for the discharge, with mercury present at a relatively low pressure, secondary processes keeping the mercury atoms largely in excited states. Experimental work was interrupted, however, and it was only recently that an opportunity arose for testing such a source in comparison with a regular quartz mercury arc.

A quartz tube 7 mm. in diameter and 20 cm. long, provided with tungsten electrodes and containing argon at a pressure of about 6 mm. and mercury vapour at a pressure corresponding to 50° C. was excited by a small wireless transformer. The voltage across the tube was 1500. Used as a source, this tube produced an intensity of resonance of λ2536 about half as great as that produced by a water-cooled quartz arc of the usual type. The arc was used without a magnetic field, but was cooled during the exposures at such a rate that it was extinguished in about a minute, thus producing the maximum intensity of resonance. The argon tube required no cooling or magnetic field and seemed perfectly steady and capable of indefinite operation without attention. I am grateful to Messrs. Foote and Mohler for apparatus used in these tests.

It is probable that the intensity of the 'gas-discharge' source can be greatly increased. The pressures given above are approximately optimum values for the particular tube and excitation used, but the possibilities of obtaining greater intensity by using greater power input (the tube was comparatively cool), end-on illumination, other gases, perhaps an arc instead of a high-voltage discharge, etc., have not been tested. The device recommends itself as it stands, however, by its great convenience of operation and the ease with which it can be constructed in the laboratory. It appears likely that this source would be advantageous for resonance measurements when using a photo-electric cell instead of photographic plates.

It is quite possible that such a gas-discharge tube has been used elsewhere as a source for mercury resonance. Dorgelo has used a similar discharge, although for a different purpose. The tube is also quite similar to those used by Wood and others for sodium, but its advantages over the much-used water-cooled mercury arc have seemed worthy of this notice.

M. A. Tuve.

Department of Terrestrial Magnetism,
Carnegie Institution of Washington,
Washington, D.C.,
Nov. 23.

Collisions of the Second Kind between Ions and Atoms or Molecules.

Some experiments dealing with collisions of the second kind between ions and atoms or molecules have been performed independently and simultaneously in two different laboratories—one at Princeton University and one at the University of California. Through correspondence the different investigators have learned of each other's results and have decided to present jointly, in this letter, a preliminary report of this phenomenon, which heretofore has been unknown. In both researches, the apparatus used are essentially those described in the positive ray experiments by Smyth (*Proc. Roy. Soc.* and *Phys. Rev.*) and by Hogness and Lunn (*Phys. Rev.*). One set of experiments is the preliminary stage of a complete study of the whole phenomenon; the other is incidental to work on the positive ray analysis of nitric oxide.

Mixtures of two gases, in equal amounts, have been ionised by electron impact, the impact electrons having velocities well above the ionisation potential of either of the gases. In each case the relative amounts of the two ions formed were determined as a function of the pressure of the gas mixture in the apparatus, and it was found that the relative amount of that ion corresponding to the higher ionisation potential decreased regularly with increase of pressure. The phenomenon can be explained only by collisions between ions and atoms or molecules, in which the ions rob the colliding atoms or molecules of one of their electrons, the process taking place with evolution of energy.

The results thus far obtained are given by the following equations:

$$\begin{aligned} He^+ + Ne &= Ne^+ + He, \\ Ne^+ + A &= A^+ + Ne. \\ A^+ + NO &= NO^+ + A, \\ He^+ + NO &= NO^+ + He. \end{aligned}$$

The ionisation potentials of He, Ne, A, and NO are 24·5, 21·5, 15·4, and 9 volts respectively.

With diminishing pressure the above reactions take place to smaller extent and, in each case, the ratio of the relative amounts of the two ions, extrapolated to zero pressure, is that due only to electron impact ionisation. This extrapolated ratio gives the relative probabilities of ionisation of the different ions. The results thus obtained are in agreement with those of K. T. Compton and C. C. Van Voorhis (*Phys. Rev.*, 27, 730, 1926).

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T. R. HOGNESS.
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University of California, Berkeley, California.

Photo-electric Polarimetry.

WITH reference to the letter from Dr. J. Kenyon published in NATURE of February 27, 1926 (vol. 117, p. 304), which I have only just happened to see, I should like to add the following.

H. von Halban and K. Siedentopf in July 1922 applied for a German patent for methods of photo-electric polarimetry. The patent was granted as No. 386,537 and taken up by the optical works of R. Winkel, Göttingen.

The processes described in their specification were critically examined by K. Mayrhofer. This investigation was finished by July 1924 and the results were embodied in a Würzburg dissertation in 1924.

The best results were obtained with an arrangement in which the variations of luminosity of the source (mercury lamp) were compensated by using two cells.[1]

The light emerging from a monochromator was split up by a quartz plate. The transmitted ray passed through a polarimeter specially built by Messrs. Winkel on a potassium photo-electric cell with argon filling, while the reflected ray fell direct on a similar cell. The voltages on the two cells were so distributed that the photo-electric currents balanced, as shown by a single-fibre electrometer. Thereupon similar vessels with the solution to be tested were introduced into the two beams. This cancelled the loss of light by absorption and left only the change due to polarisation, which was then compensated by rotation of the nicol.

With this method measurements were made on the mercury lines down to 2536 Å.U. The readings could be reproduced with an accuracy of 0·01° in the strong ultra-violet lines, and rather less accurately in the feeble lines.

The same method can of course also be used for absorption measurements, and results were obtained for potassium chromate which agree well with those obtained by other methods.[2]

If, however, only absorption measurements are required, it will be found better to use the two-cell method of von Halban and Siedentopf (*ibid.*), since the polarimeter, with its many reflecting surfaces, introduces much loss of light.

A detailed publication of Mayrhofer's measurements will appear shortly in the *Zeitschrift fur physikalische Chemie*.

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The Double Normal State of the Arc Spectrum of Fluorine.

IN NATURE of December 4, p. 804, Mr. de Bruin suggests that Millikan's complex hot spark lines of fluorine, at λλ607,657, are to be attributed to FI. The components of these lines exhibit intervals which, within the rather wide range of experimental error in this difficult region, are equal to the intervals Δ^4P_{12}, $\Delta^2P'_{12}$, and Δ^2P_{12} occurring among the red lines of FI, but it does not appear possible to form the groups into complete multiplets in such a way as to give the equalities undoubted significance. The assignment of these groups to FI is very hazardous, in view of the fact that they have been produced only under the extreme conditions of the hot spark. It may be recalled that Millikan at first assigned them to FVII.

In a recent paper (*Proc. Roy. Soc.*, A, 113, p. 323) I have given evidence that the ionisation potential of the neutral fluorine atom is approximately 17 volts. The ultra-violet groups in question correspond to excitation potentials of about 20 volts and 19 volts respectively. It would appear, therefore, that if Mr. de Bruin's assignment is correct, the groups must require the simultaneous excitation of two or more electrons for their production. This is unlikely, in view of the satisfactory correlation of the terms involved with those predicted by the Heisenberg-Hund theory on the supposition that only one 2_2 electron is excited. It therefore seems probable that the extreme ultra-violet lines are emitted by a fluorine atom which has been ionised one or more times.

HERBERT DINGLE.
Imperial College of Science and Technology,
South Kensington, S.W.7, Dec. 6.

Rate of Work done by Athletes.

IN an article by Dr. J. S. Haldane and Dr. Y. Henderson in NATURE of August 28, p. 309, are references to the rate at which a man in good physical training can do work. For example, in a mile and a quarter rowing race the rate was 0·57 horse-power; and again, Douglas and Haldane, for short bursts of climbing, reached a rate of 0·9 horse-power.

It occurred to us that these rates might be exceeded by a runner raising his own weight against gravity when dashing up a flight of stairs with a running start. These experiments were easily carried out with a stop watch, and the rates obtained by a young man aged twenty-five years were, for a height of stairs mounting to 7½ feet, 13 feet, and 125 feet vertically, 1·87, 1·70, and 0·87 horse-power. The last experiment is a severe tax on the heart, and is not one to be recommended.

An interesting question is the efficiency per pound weight of the athlete. This resolves itself into the simple question of the vertical velocity, and in such experiments a man would probably have to take second place to a dog, a cat, or a sparrow. What is the most efficient living creature?

A. S. EVE.
A. J. FLEMING.
McGill University, Montreal,
Nov. 27.

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[1] H. Meyer u. H. Rosenberg, *Vierteljahrsschrift d. astronom. Ges.*, 48, 3, 210 (1913). H. v. Halban u. H. Geigel, *Z. f. phys. Chemie*, 96, 214 (1920). H. v. Halban u. K. Siedentopf, *Z. f. phys. Chemie*, 100, 208 (1922). H. Rosenberg, *Z. f. Physik*, 7, 18 (1921).

[2] H. v. Halban u. K. Siedentopf, *Z. f. phys. Chemie*, 100, 208 (1922).

Total Solar Eclipses in the British Isles.

By Dr. W. J. S. Lockyer.

On June 29 of this year the sun will be totally eclipsed over a belt of northern England. Unfortunately, this event takes place very early in the morning, the total phase beginning at about 5h 24m G.M.T. or 6h 24m B.S.T., so that the sun will be only about 12° above the north-eastern horizon. Nevertheless, even under these rather unfavourable conditions, every one who has never seen the sun totally covered by the moon should make an effort on June 29 to be somewhere on that belt of country from which to see the striking spectacle of a total solar eclipse.

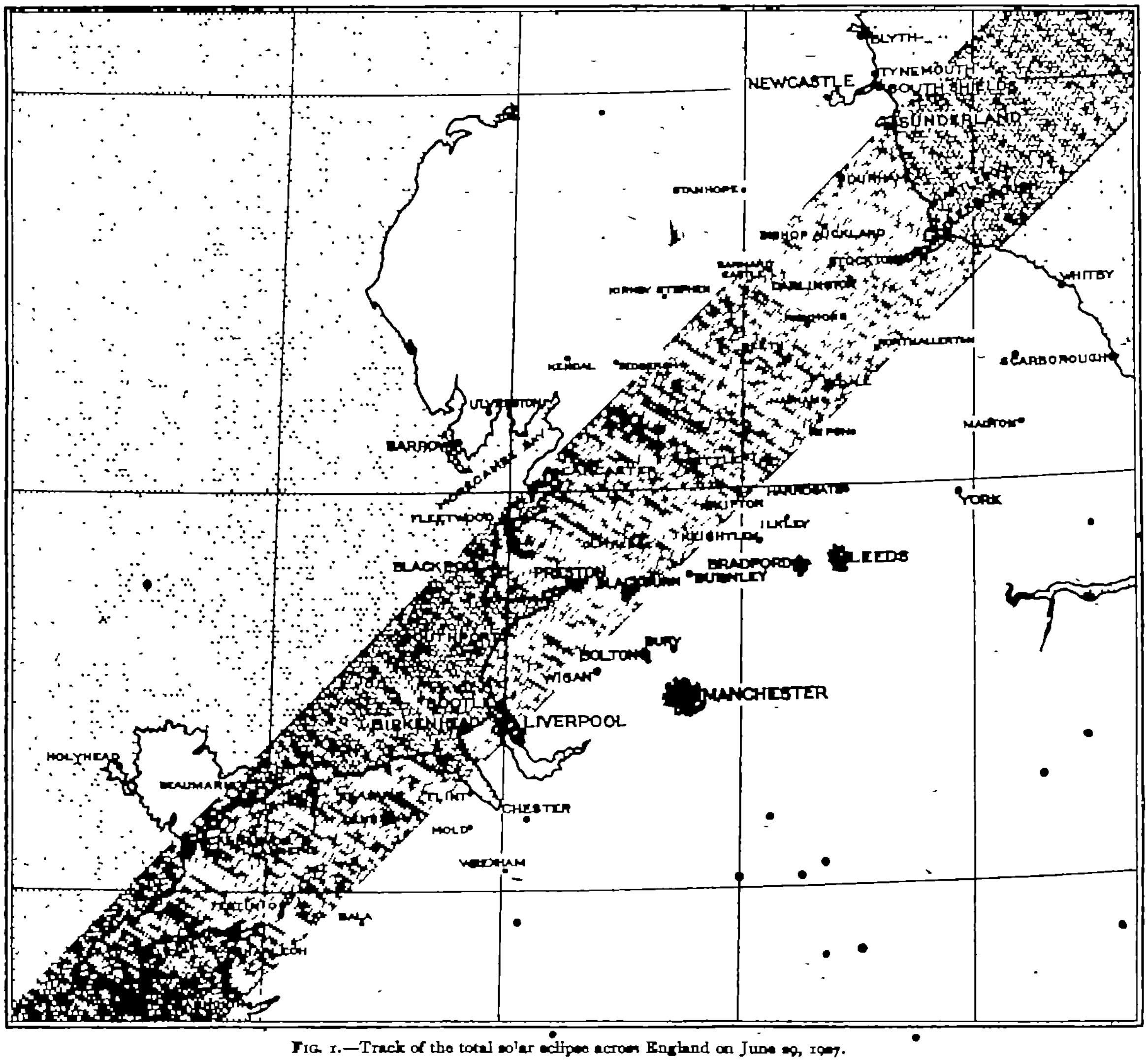

Fig. 1.—Track of the total solar eclipse across England on June 29, 1927.

An approximate position of the path of the moon's shadow is indicated on the portion of a map of England illustrated in Fig. 1. The breadth of the belt is about 30 miles, and the nearer the observer is to the centre of this belt the longer is the duration of totality. The central line of totality strikes the west coast of Britain near Criccieth, in Carnarvon, passes over Southport and nearly over Preston. It then sweeps over the north part of Yorkshire, and passes over Settle and Richmond, finally leaving the coast in the southern portion of the county of Durham, and passing over Darlington and Hartlepool and a little to the north of Stockton. The duration of totality is about 24 seconds, but is a little shorter than this on the west coast and a little longer on the east coast. Large towns just inside the border line of this belt are Carnarvon, Liverpool, Burnley, Skipton, Lancaster, and Durham.

So far, reference has been only made to that part of the track of the moon's shadow which first crosses England after commencing in the eastern Atlantic. Its later course is north-easterly, extending over Norway, Sweden, Lapland, and skirting the west coast of Novaya Zemblya. It then strikes easterly over the Arctic Ocean and north-westerly over north-eastern Siberia, terminating its course in the north-western portion of the Pacific Ocean.

The most satisfactory places for large, well-equipped expeditions will undoubtedly be in Sweden and northern Norway, for there the sun will be well up in the sky and the eclipse of longer duration.

Formerly there were many problems that could be investigated only during a total eclipse of the sun. The rapid advancement of solar physics during the last half-century has so considerably reduced these in number that the importance of observing eclipses from this point of view is much reduced. Thus, it is now known that the corona is a solar and not a lunar appendage; that the prominences can be seen whenever the sun is visible without having to wait for an eclipse to observe them; the study of the spectrum of the chromosphere in the photographic region is not now so important as it was; Einstein's theory of the bending of light by solar influence has been proved and requires no further repetition.

The main problems still to be studied are the exact times of the four contacts for the problem of the moon's motion; the red end of the chromospheric spectrum; the spectrum of the corona, best studied when the sun is in its greatest state of activity; and, finally, the form of the corona. Even the last mentioned is nearing solution, because it is now ascertained that coronal matter is closely associated with prominence matter, and that the positions of the prominences as regards solar latitude are intimately tied up to the positions of the coronal streamers. Thus it is well known that the

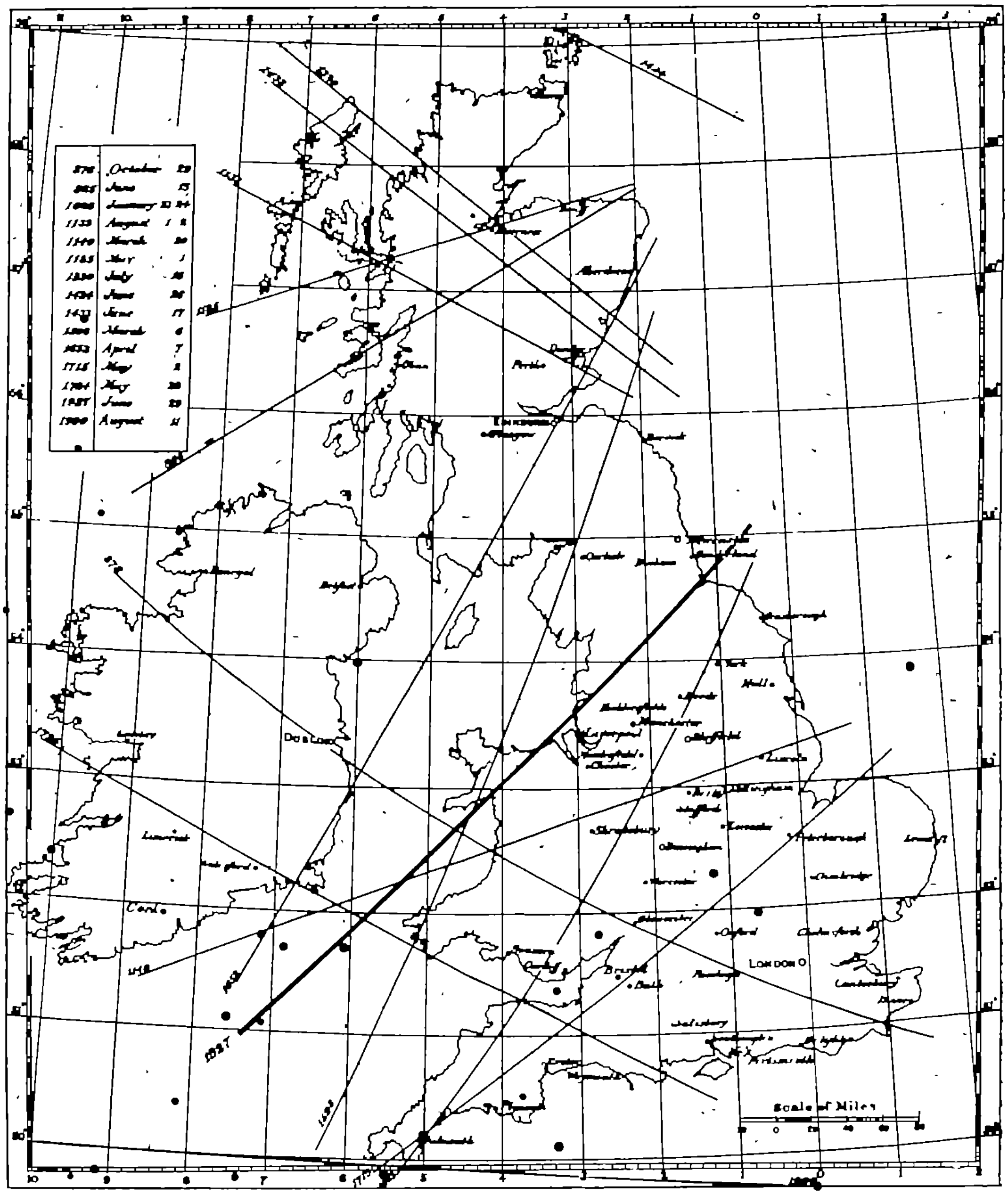

FIG. 2.—Map of total solar eclipses visible in Great Britain and Ireland from 878 to 1999.

form of the corona assumes one of three main types, a polar or maximum form, an intermediate or square form, and a minimum or wind-vane form. The polar form only occurs when the prominences are active near the solar poles. Next year the prominences will be near the poles, so that the type of corona is expected to be of the ' polar ' or ' maximum ' type.

In connexion with the passing of the moon's shadow over England this year, it is of interest not only to refer to other total eclipses visible in the British Isles, but also to inquire when the next one will take place. A very interesting map was published in the *Monthly Notices of the Royal Astronomical Society* in 1885 in a paper by Mr. J. Maguire, entitled "Total Solar Eclipses Visible in the British Isles, 878–1724." This map is here reproduced (Fig. 2) in a simplified form, to show the centres of the tracks only: those for 1927 and 1999 have also been inserted.

The eclipses here represented commence with the year A.D. 878, and show that thirteen total solar eclipses have occurred in the British Isles since and including that date. The last to take place was that of 1724, so that no total eclipse of the sun has occurred in these islands for the last 203 years.

Accounts of early English eclipses, whether total or partial, are generally alluded to in the "Saxon Chronicle." Thus, the very first record of one occurring in Great Britain, namely, the partial eclipse of A.D. 538, is referred to in the "Chronicle" in the following words: "In this year the sun was eclipsed fourteen days before the Calends of March from early morning till nine."

For the year A.D. 733, the "Chronicle" relates that "in this year Ethelbald captured Somerton; and the Sun was Eclipsed, and all the Sun's disk was like a black shield; and Acca was drawn from his bishopric." According to the Rev. S. J. Johnson, this eclipse was not total but annular, and is the first record of such an eclipse in England.

Omitting references to later eclipses, and coming to that of A.D. 1140, this was total over England, the centre of the track just skirting the south of Ireland, and leaving the east coast of England about the town of Lincoln. About this eclipse the "Chronicle" states: "In the Lent the sun and the day darkened about the noontide of the day, when the men were eating; and they lighted candles to eat by. That was the thirteenth day before the Calends of April. Men were very much struck with the wonder." This eclipse was evidently a very dark one, for William of Malmesbury stated that "while persons were sitting at their meals, the darkness became so great that they feared the ancient chaos was about to return, and upon going out immediately, they perceived several stars about the Sun."

The Scottish eclipse of 1652, when the central line passed near Wicklow in Ireland, and left the east coast of Scotland at Peterhead, is of interest because it was the first eclipse observed in the British Isles after the telescope had first been used in the eclipse of 1612.

The total eclipse of 1715 was of special importance to British observers, because London came well into the shadow belt, the central line passing over Falmouth in Cornwall and leaving the east coast at King's Lynn in Norfolk. Another interesting feature was the fact that the celebrated astronomer Halley received orders from the Royal Society "to provide for the observation to be made at their house in Crane Street," and for this purpose he published a special map showing the whole shadow path over England. With regard to this map he wrote:

> "Having found, by comparing what had been formerly observed of Solar Eclipses, that the whole Shadow would fall upon *England*, I thought it a very proper opportunity to get the Dimentions of the Shade ascertained by observation; and accordingly I caused a small Map of *England*, describing the Track and Bounds thereof, to be dispersed all over the Kingdom, with a Request to the Curious to observe what they could about it, but more especially to note the Time of Continuance of Total Darkness, as requiring no other Instrument than a *Pendulum Clock*, and as being determinable with the Utmost Exactness by reason of the momentaneous Occultation and Emersion of the luminous Edge of the Sun, whose least Part makes Day. Nor did this fail of the desired Effect, for the Heavens having proved generally favourable, we have received from so many Places so good Accounts, that they fully answer all our Expectations, and are sufficient to establish several of the Elements of the *Calculus* of Eclipses, so as for the future we may more securely rely on the Predictions: Though it must be granted, that in this our Astronomy has lost no Credit."

Halley seems to have collected quite a large party at Crane Court, for he says that

> "There were with us a great many members of the Society. and the Right Honourable the *Earl of Abingdon*, and the Lord Chief Justice *Parker* were of the number: . . . There were also present Gentlemen of other Nations, and among them Monsieur *le Chevalier de Louville* and Mr. *Monmort*, both of them Members of the *Royal Academy of Sciences at Paris*."

Even in 1715 the occurrence of a total eclipse was quite likely to alarm the people, for Halley thought it advisable to warn the public as he states below:

> "The like Eclipse having not for many ages been seen in the Southern Parts of Great Britain, I thought it not improper to give the Publick an account thereof, that the sudden darkness, wherein the Stars will be visible about the Sun, may give no surprize to the People, who would, if unadvertized, be apt to look upon it as ominous, and to interpret it as portending evill to our Sovereign Lord King George and his Government, which God preserve."

The observation of this eclipse was favoured with fine weather, and Halley describes how the

> "face and colour of the sky began to change from a perfect serene azure blue to a more dusky livid colour, intermixed with a tinge of purple, and grew darker and darker till the total immersion of the Sun."

The well-known phenomena of 'Baily's beads,' first named such after the observation in Scotland of Mr. Baily at the annular eclipse of the sun of May 15, 1836, was distinctly noted by Halley in this eclipse of 1715, for he stated that "about two Minutes before the Total Immersion, the remaining Part of the Sun was reduced to a very fine Horn, whose Extremities seemed to lose their Acuteness and to become round like Stars."

During the total obscuration, which lasted 3^{m} 22^{s}, the planets Jupiter, Mercury, and Venus, as well as the stars Capella and Aldebaran, were seen with the naked eye, and "there appeared a luminous ring around the moon as on the occasion of the eclipse of 1706." This luminous ring or corona was regarded at that time as a structureless aureole appertaining to the moon and not, as we know it now, the upper regions of the solar atmosphere, only visible during total eclipses.

Those who have observed total eclipses are familiar with the feelings of weirdness of the occasion, the chilly and damp nature of the air, and the behaviour of animal life, and many who will observe their first total eclipse this year will also be able to corroborate the following account of the 1715 eclipse given by Halley:

> "I forbear to mention the *Chill* and *Damp* with which the Darkness of the Eclipse was attended, of which most *Spectators* were sensible and equally *Judges*: or the Concern that appear'd in all Sorts of *Animals, Birds, Beasts*, and *Fishes* upon the Extinction of the Sun, since ourselves could not behold it without some sense of Horror."

The eclipse of 1715 was followed by that of 1724, which took place in the month of May, and was the last to be observed as total in Great Britain. The track of totality passed over the southern portion of Ireland and the south-west portion of England, London being situated just outside the northern boundary. This eclipse was well observed, and Halley again played an important part in connexion with it.

After June 29, 1927, the next total eclipse that will be of special interest to observers in the British Isles is that which will occur in 1999 on August 11 (see Fig. 2). The central portion of the track just skirts the extreme southern coast of Cornwall, so that totality will only be visible to those stationed in the extreme south-west of England. At that remote epoch it is difficult to forecast what the work of the astronomer will be. It is safe to say, however, that the problems now studied during total solar eclipses will all be solved, but it is almost as certain that new problems will have arisen which will necessitate possibly still greater attention being paid to the study of the sun under eclipse conditions. Even if there were no scientific reasons for observing total solar eclipses, they must still attract close attention by reason of the remarkable solar phenomena which then become visible and the weird and awe-inspiring feelings which are aroused by the spectacle.

Spinning Electrons.

By R. H. FOWLER, F.R.S.

THE past fourteen or fifteen months have seen some striking advances and simplifications in theoretical physics. The trench warfare of the preceding three years, which consolidated the ground and marked out slowly the key positions for the new attack, is past. That attack has been launched with almost complete success. The first fury of the advance is perhaps now over. At least it is now possible to survey our older difficulties afresh, to find in many cases that they are no longer formidable. It therefore seems the right moment, and perhaps of general interest, to try to indicate the parts played in this advance by the more striking of the ideas associated with it—in this article the spinning electron. In a later article it may be possible to discuss similarly the other primary conception—the new mechanics, and particularly Schrödinger's equation. Without any assertion of finality in the description of electronic interactions by its means, the importance of the spinning model of the electron can scarcely be over-estimated. Yet the spinning electron has been so lost in the far wider ideas embodied in the new mechanics that it is as yet scarcely appreciated at its full value. It is convenient therefore to devote this article to it alone.

Without prejudice to the difficult prior questions of internal structure, we may regard the electron merely as a singularity in space—the source of the external field by which it is known to us. Until recently this singularity has always been assumed to be the simplest possible, with the external field of an electrostatic point charge acting radially and symmetrically in all directions. The first serious suggestion that the electron should be treated as a more complicated singularity appears to have been made by A. Compton (*Jour. Franklin Inst.*, 192, 145, 1921). In connexion with a survey of gyromagnetic, diamagnetic and ferromagnetic phenomena he suggested that the singularity might be such as to give rise to the magnetic field of a magnetic doublet besides the usual electrostatic field. Structurally, such an electron must have an axis of symmetry—the doublet axis—and it is natural to think of its magnetism as arising from a spin of its charge about this axis, which will therefore also be its axis of mechanical angular momentum. The fields above mentioned are of course the fields of the electron relative to a set of axes in which its centre is at rest. Relative to other axes they must be derived by the transformation of Lorentz.

We will now show in turn how the use of this more complicated model of the electron resolves the remarkable set of paradoxes in which atomic theory had involved itself by the spring of 1925, owing, as we now see, to the use of an inadequate mechanical model. The most clear-cut of these depends on the statistical conception of weight, so that its appeal is perhaps not so direct as that of some of the others. We know, by a purely enumerative study of atomic spectra and their structure in magnetic fields, the total number of states which must be associated with any one spectral term of an atom or ion. This total is the statistical weight of the term. We know further that spectral terms can be grouped into sets, each characterised by a maximum multiplicity R. If R is one, all the terms are single. If R is two (for example, for sodium), the S terms of the set are single and the rest double, and so on. The weight, as counted above, for an S term of a spectrum of maximum multiplicity R is always R. Now the normal state of any once ionised atom is the core of the atom during the various stages of capture of the next electron. The weight of the core is therefore R, indicating that it can split under perturbation into just R different states. The new electron then comes in, and describes its possible orbits about the core in an approximately central field of force. If the electron is a point charge there seems no escape whatever from the conclusion that the total number of states of total quantum number n must be asymptotically equal to n^2 for large n, and the total number of states of core and orbital electron Rn^2. The actual number found is $2Rn^2$ for all n in all cases. No form of the quantum theory yet propounded offers a rational escape from this paradox, *unless the electron has a structure*. The difficulty of avoiding the enumerative difficulty in any other way is exceedingly grave, though it lies rather deep and is not readily appreciated. Its gravity comes from the fact that it depends solely on the number of degrees of freedom and an asymptotic approximation at great distances to the law of the inverse square for the force between the electron and the ion, which can scarcely be called in question. If, however, the electron spins and can set its axis at just two inclinations relative to the plane of its orbit, the paradox disappears.

The second paradox was the better-known anomalous Zeeman effect. By Larmor's theorem the action of a magnetic field on any stationary state of any atom should split the state into a number of states equidistantly spaced, and this spacing should be the same whatever the original state. As a result every spectral line should split into a certain triplet called the normal Lorentz triplet. In fact, such triplets are rare, being found only for lines of singlet systems. The general more complicated splitting structures found can be formally described by assigning to each state a splitting factor g depending on the type of the state. Larmor's theorem asserts that $g=1$ always. It has been known for some time that the anomaly could be formally explained if the magnetic moment of the atom arose from two sources, of which one was the orbital angular momentum contemplated by Larmor's theorem. The other source must then be such that its ratio (magnetic moment)/(mechanical moment) is twice the ratio of the magnetic and mechanical moments arising from orbital motion. The spin of the electron provides just this source of supply, and exact examination shows that it provides a complete explanation.

The third paradox was the so-called relativity-doublet formula, for the separations found between pairs of X-ray or pairs of optical terms. Familiar cases are the separations of the $K\alpha_1$, $K\alpha_2$ X-ray doublet and the D-lines of sodium. The separations which obey the theoretical formula vary in absolute magnitude by a factor of 10^7, which is accounted for by its salient feature, a factor approximately Z^4, where Z is the atomic number. It was thought most unlikely that any other type of perturbation could supply just this vital factor, but it is impossible rationally to accept this origin. For if we do, the sodium doublet, for example, must be interpreted as due to the difference of energy, owing to the variation of mass with velocity, of orbits of azimuthal quantum numbers one and two and the same total quantum number in an inverse square field. At the same time the much greater difference between the *pair* of P orbits and the S orbit, for example, must be interpreted as a difference of energy due to differences of penetration into a non-inverse-square field again by orbits with different azimuthal quantum numbers one and two. The pair of P orbits must for one purpose have the same and for another different azimuthal quantum numbers! If, however, the electron has a magnetic moment, there will be a secular perturbation of its axis by the magnetic field which arises from the linear velocity of the electron in the field of the nucleus, and a corresponding secular perturbation of the plane of the orbit. We can at once show from this that the energy of a single orbit in a central field of force splits up into a set of energies the differences of which vary as Z^4 as required. Finally, if the ratio (magnetic moment/mechanical momentum) required for the Zeeman effect is assigned to the electron, and the calculation of the perturbation exactly carried through, we obtain the proper quantitative formula for the doublet separation. This now enters as the difference of energy between orbits, otherwise the same, for which the momentum of the electron $h/2\pi$ has its two different orientations with respect to the plane of its orbit.

It was of course this success which finally established the value of the spinning electron. The idea and its development in this connexion we owe to Goudsmit and Uhlenbeck. Bichowsky and Urey obtained independently most of the same results. The finally correct numerical form of the separation formula is due to Thomas.

Two further paradoxes may be mentioned. One was that it appeared from a study of the behaviour of spectra in strong magnetic fields (Paschen-Back effect) that four quantum numbers must be used to specify the orbit of an electron. If the electron is a structureless point, with therefore three degrees of freedom, three quantum numbers are the maximum allowed by any form of quantum theory yet proposed. But if the electron has a rigid structure, it has in all six degrees of freedom. If further, as is assumed, its axes of spin and angular momentum always coincide, its orbits can be fully described by five quantum numbers, of which one, defining the magnitude of the spin, is invariable and may be ignored.

The last paradox to be mentioned is the following. In spite of numerous attempts to produce a coplanar model of the helium atom, most physicists have remained convinced that the normal state of helium must correspond to orbits filling three-dimensional space round the nucleus. But there was then the grave difficulty that a diamagnetic atom could not result. Two equal moment-vectors cannot have a zero resultant unless they are oppositely directed and the orbits coplanar. But when the moments of the electrons are added, there are four vectors to combine and the difficulty disappears.

We see then how the spinning electron has brought order out of chaos in the broad outlines of atomic theory. Its necessity and its successes are qualitatively independent of the new mechanics. Without in any way underrating the importance of the new mechanics, it is fair to say that its first effect on the determination of atomic weights and energy values is confined to small adjustments, such as replacing an integer n by $n+\frac{1}{2}$, or n^2 by $n^2-\frac{1}{4}$. (It is not until we come to the extremely important resonance theory of Heisenberg that the new mechanics brings in primary effects on the energy values.) These refinements are of course necessary for the correct theory. But the broader difficulties we have been discussing depend solely on the spinning electron for their solution, and order reigns once again.

It would not be right in a description of the recent work on the spinning electron to pass over in silence a remarkable essay by L. V. King.[1] This embodies an attempt to break right away from the recent trend of atomic physics, to find in *h* a characteristic constant of a spinning electron, and to develop thereby an almost classical theory of matter and radiation which hopes to avoid all the old classical difficulties without appeal to external postulates such as those of the quantum theory. The exposition given hitherto is, it must be confessed, difficult to follow, and it is difficult to believe that the author has really proved all that he states. A fuller exposition would clear up such points. There is much to admire in gallant excursions such as this; whether they turn out right or wrong it is by such excursions that physics lives.

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[1] "Gyromagnetic Electrons and a Classical Theory of Atomic Structure and Radiation" (Montreal: Louis Carrier; Cambridge: Heffer.) 5s.

Obituary.

Mr. T. S. P. Strangeways.

THOMAS STRANGEWAYS PIGG STRANGEWAYS, who died prematurely after a month's illness at Cambridge on Dec. 23, was a retiring man of strong character who had done remarkable work in pathology and tissue culture. Born on Dec. 28, 1866, his original name was Pigg, which he changed to Strangeways on his marriage. Educated medically at St. Bartholomew's Hospital, where he obtained the Matthews Duncan gold medal (1895) and took the qualification of the Conjoint Examining Board (M.R.C.S., L.R.C.P.) in 1896, he was assistant curator of the Museum and came under the inspiring influence of the late A. A. Kanthack, with whom he early collaborated in the *Journal of Pathology and Bacteriology* and in the *Transactions of the Pathological Society of London*. He accompanied that distinguished pathologist when in 1897 he left St. Bartholomew's to become professor of pathology at Cambridge.

Strangeways was appointed demonstrator of pathology in 1897, and held this office under Sir German Sims Woodhead until after the War, so that many generations of Cambridge medical students hold his teaching in grateful remembrance. His handbook on "Clinical Pathology and Practical Morbid Histology" passed into a seventh edition in 1912. He was made an honorary M.A. of the University in 1900, and in 1905 became the first Huddersfield lecturer on special pathology, this endowment being provided by a fund collected by Sims Woodhead from friends residing in or connected with Huddersfield.

Up to this time, Strangeways' life and work had been those of an ordinary university demonstrator, but he now struck out a new line in the intensive study of special diseases of a chronic nature and, under the ægis of a strong committee, energetically and successfully organised a special hospital for the investigation of selected cases. This research hospital, at first in a small private house, was in 1912 properly accommodated in a specially built hospital which was opened on May 24 by the late Sir Robert Brown of Preston, a generous benefactor to the institution. Already four thousand cases of rheumatoid arthritis had been exhaustively investigated pathologically, clinically, and therapeutically; researches had been made into gout, purin metabolism, and the opsonic index by Strangeways and the keen collaborators he gathered together; the results of these researches were collected in the five well-illustrated volumes of the "Bulletin of the Committee for the Study of Special Diseases." The museum of the research hospital contained 2000 arthritic joints dissected and mounted by him.

For the first three years of the War the work was suspended, as the hospital was given over to wounded officers, but continuation of the work showed that at least seven pathological forms of rheumatoid arthritis can be recognised clinically. In 1923 the wards of the hospital were again closed for a time in order to concentrate on tissue culture *in vivo* and *in vitro*, with the object of studying cancer patients in the hospital. The extremely valuable results thus obtained appear in Strangeways' papers in the *Proceedings of the Royal Society*, and his books, "Tissue Culture in Relation to Growth and Differentiation" (1924) and "The Technique of Tissue Culture *in Vitro*" (1924). His observations on the effect of X-rays and radium on tissue cells growing *in vitro* deserve special attention. Thus beginning as a pathologist, he became a biologist, as was eloquently shown in "G. P. B.'s" tribute in the *Times* of Dec. 30.

Strangeways had the power of communicating his enthusiasm to others, and was a lovable collaborator. He bore his infirmity of deafness with admirable patience, and has left a memory behind him which his friends will ever regret. Unfortunately his family are left with very scanty means, and five of his seven children are boys whose education is not completed, the youngest being eight and the eldest twenty-one years of age.

H. R.

Prof. R. W. Phillips.

The late Prof. Reginald W. Phillips, who had been head of the Department of Botany at the University College, Bangor, for nearly forty years, was born at Talgarth, Breconshire, on Oct. 15, 1854. He took the two years' course of training at the Bangor Normal College, where he was certificated as elementary school teacher in the December of 1874. During 1875 he was headmaster of a school in Ferndale, but soon left to become lecturer at his old college, where he remained until 1881. He then became a scholar of St. John's, Cambridge, at the same time studying for the London B.Sc. In 1884 he was appointed head of the Department of Biology at the newly established Bangor College, and a little later he became professor of botany. As the University of Wales had not then come into existence, the college confined itself to the preparation of students for London degrees; and as there was no efficient system of secondary education the devoted band of teachers at the college had, for years, to hold matriculation classes, in addition to the ordinary degree courses.

Prof. Phillips was a keen observer, and an excellent field naturalist. He became an enthusiastic student of the marine algæ; especially of the Florideæ. He supplied the article on "Algæ" to the eleventh edition of the "Encyclopædia Britannica"; and during the years 1895–1897, contributed to the *Annals of Botany* a series of valuable studies of "The Development of the Cystocarp in the Rhodomelaceæ," "The Rhodymeniales," etc.

In 1898 Phillips obtained his London D.Sc., and at this time became so engrossed in problems of Welsh education, acting as chairman of the governors of the Bangor secondary schools, and later on adding to these duties those of magistrate, that he dropped his research work—a source of grief to those who, like the present writer, knew what a loss this meant to science.

In the October of 1922 he retired from the service of the college, but in spite of frequent attacks of heart trouble and of the disease which ultimately proved fatal, he took up once more his interrupted algological studies and the following papers were published: "On the Structure of *Spyridia filamentosa*," *Annals of Botany*, 38, 1924; "The Ceramidium of *Polysiphonia*," *New Phyt.*, 23, 1925; "On Vacuolar Pseudopodia in *Callithamnion sp.*," *Rev. Alg.*; "On the genera Phyllophora, Gymnogongrus, and Ahnfeldtia and their Parasites," *New Phyt.*, 24, 1926; "On the Form of the Protoplast in Cells of the Genus Ceramium and those of *Dasya coccinea*," *New Phyt.*, 25.

During the past year Phillips suffered much from spinal trouble; he was taken to London and operated upon, but unsuccessfully; and on Dec. 2 he died at Leominster.

MR. S. M. EDWARDES, C.V.O., C.S.I.

THE premature death from bronchial pneumonia of Stephen Meredyth Edwardes, at the age of fifty-four years, which took place on Jan. 1 at Fielden, near Boxmoor, is a loss to the study of Indian history and archæology deeply to be deplored. Mr. Edwardes was a son of the Rev. Stephen Edwardes, fellow of Merton College, Oxford, and was educated at Eton and at Christ Church. In 1894 he passed into the Indian Civil Service, and was posted to the Bombay Presidency. The intimate acquaintance with conditions among the native population of the city which he soon acquired, and his profound knowledge of its history, on which he was widely recognised as the foremost authority, were employed to full advantage in his census volume of 1901, the additional volumes of the "Gazetteer" which he compiled between 1906 and 1910, and his "Rise of Bombay" and "Byways of Bombay." This knowledge, in combination with his personal qualities, made him eminently fitted for the post of Commissioner of Police, to which he was appointed in 1910. His well-balanced and admirably judicious "Crime in India," published in 1925, showed that no one could have been better qualified to represent India at the Geneva conference on traffic in women and children which he attended in 1921.

On his retirement, Mr. Edwardes became secretary to the Indo-British Association, an organisation formed to oppose the Montagu-Chelmsford reforms; but his chief interest lay in research. In 1923 he became joint editor with Sir Richard Temple of the *Indian Antiquary*. He revised Grant Duff's "History of the Mahrattas" and the fourth edition of Vincent Smith's "Early History of India." He was engaged in a comprehensive study of the Mogul period in collaboration with Prof. Garrett of Lahore, and in this field had already published a study of "Babur: Diarist and Despot." In 1926 he was selected to succeed Miss Ella Sykes as secretary of the Royal Asiatic Society.

SIR FRANCIS FOX.

BY the death on Jan. 7, at the age of eighty-two years, of Sir Francis Fox, the engineering world loses one of its oldest and most distinguished representatives. Four years younger than his brother Sir Douglas Fox (1840–1921), Sir Francis Fox was the son of Sir Charles Fox (1810–1874), whose earliest engineering experience was gained under Ericsson at the famous Rainhill locomotive trials and under Robert Stephenson on his London and Birmingham Railway; and he also became known as the constructor of the Great Exhibition building of 1851. From about 1860 onwards, father and sons were responsible for railways, bridges, and tunnels in both hemispheres, among which may be mentioned the Mersey Tunnel, the Liverpool Overhead Railway, the Great Northern and City, and Charing Cross and Hampstead Tubes; railways in India, Argentina, Canada, and Africa, and also the great bridge over the Victoria Falls on the Zambezi River. The firm in its earliest days was Fox, Henderson and Co., but was changed first to Sir Charles Fox and Sons and then to Sir Douglas Fox and Partners.

In his book, "Sixty-three Years of Engineering, Scientific and Social Work," Sir Francis Fox gives an account of many of these undertakings, and it is there he illustrates the remarkable accuracy with which tunnels can now be bored, the discrepancy in the tunnel between Hampstead Heath Station and Belsize Park, London, 4000 feet long, being only ½ in. In the case of the Simplon Tunnel, of which he was one of an international commission, the error was 3⅝ in. in 12½ miles.

In later years Sir Francis Fox did much important work in connexion with the preservation of old bridges, churches, and cathedrals; using the grouting machine for filling cracks and crevices in the masonry with liquid cement. In his valuable work on the preservation of Winchester Cathedral he was associated with Mr. T. G. Jackson, R.A. In 1912 he was also called upon to report on the condition of St. Paul's Cathedral.

No notice of the career of Sir Francis Fox, however, would be complete without reference to the social work for the less fortunate which he did in London with his brother. During the War, too, he visited the hospitals, lectured to the convalescent, and was instrumental in supplying large quantities of bandages by removing the linen from old engineering plans obtained from many sources. Knighted in 1912, Sir Francis Fox was twice married and leaves one son and three daughters, of whom the eldest, Dr. Selina Fox, was the founder of the Bermondsey Hospital and Medical Mission, a work in which Sir Francis took the greatest interest.

News and Views.

THE radio-telephone service between London and New York was opened successfully to public use on Jan. 7. Those who took part in the conversations for the first time were most favourably impressed by the clearness of the articulation, the voices of the speakers being at once recognisable. After sunset on Jan. 7 on the eastern side of the Atlantic the atmospheric conditions became very bad, which is quite an unusual occurrence for this time of the year. Yet still nearly all the subscribers who had booked times in advance were able to hold conversations. In six minutes the *Times* exchanged more than 600 words with its correspondent in New York, there being only one or two pauses for repetition. Sixty-eight years ago, Queen Victoria sent a message to President Buchanan at the rate of one word a minute, and eighteen years later Graham Bell talked to the future Lord Kelvin by telephone over the length of a room. Kelvin was filled with wonder, and pictured many developments which have come to pass. But even he never imagined that easily recognisable tones could be transmitted through 3000 miles of empty air without wires or cables almost as quickly as light. First we send signals, next we speak, and in the future we doubtless shall be able to see over thousands of miles. At present this long-distance telephone service is limited to telephone users in the neighbourhood of London and New York, but we look forward to this restriction being removed shortly, as telephone communication is now possible with towns on the Pacific Ocean. We do not think that differences in local times will have much effect on the traffic in long-distance communication.

THE sixteenth report of the Development Commissioners for the year ending Mar. 31, 1926, is arranged in four sections, the first two of which relate to the advances recommended for the development of agriculture, rural economy, fisheries and harbours, and describe the purposes for which these advances are being used. The third part relates to action taken in connexion with the compulsory acquisition of land, while the fourth deals with the financial position of the Development Fund at the close of the year. The research institutes, the activities of which are described, are the result of a scheme planned fifteen years ago, about half of them being already at work at the beginning of the War. After the armistice the interrupted programme was resumed, and there has since been a rapid increase, both in the scope of the work and in the financial needs of the stations. Grants in respect of maintenance from the Development Fund have increased approximately from £35,000 in 1919–20 to £160,000 in 1925–26. The original programme for establishing institutes has now been substantially completed, and although new branches of inquiry must be anticipated, it may be stated that a period of relative stability has been reached.

PARALLEL with the scheme for research institutes, a new plan has been developed for investigating local problems and providing advice for farmers. The principal extension in this case is in connexion with soil surveys, the agricultural departments having the co-operation of the Geological Survey. Developments have also occurred in another inter-departmental scheme, namely, that between agricultural institutes and the Meteorological Office, and some twenty stations are now carrying out investigations on the effect of weather on crops. In both these cases the methods of observation are of a tentative nature at present, and will, in all probability, be modified as the work extends. Variety testing of crops is a further important line of investigation which has only recently been developed, but work of this nature is already being carried out at five stations. As regard rural developments, the newly formed county rural community councils are proving successful. Both English and Scottish fishery departments, in addition to sharing in the general hydrographical and plankton investigations and statistical surveys organised by the International Council, are chiefly concerned with that part of the scheme which deals with the herring, cod, plaice, and haddock fisheries. Reports of the work done at the various laboratories are given, together with the papers published during the year. The experiment on land reclamation and improvement at Methwold, carried out at heavy cost to the Development Fund, is but briefly referred to, since a fuller report for the benefit of agriculturists is being prepared by the Ministry. The report concludes with a schedule of the loans and grants made in the past year, the total advances amounting to £558,392 as compared with £513,279 in the previous year (1924–25).

PROF. A. V. HILL, University College, London, Foulerton research professor of the Royal Society, is sailing on Jan. 15 for the United States, where he is to deliver a course of eight Lowell lectures at Boston during March, entitled "Living Machinery," and to act as visiting lecturer in chemistry at Cornell University for the semester February to May inclusive. The scheme of visiting lectureships at Cornell, arranged by Prof. L. M. Dennis through the generosity of Mr. G. F. Baker, enables the University each semester to bring men of science from abroad to work there; that is, to continue their researches and to give series of lectures upon them. Chemistry seems to be interpreted at Cornell in a liberal sense, for Prof. Hill is to work on the physiology of severe muscular exercise in man, using the Department of Chemistry as his headquarters, athletic students as experimental subjects, and the Department of Physical Training as an experimental ground. His lectures will deal with such subjects as speed of movement, rate of recovery, and the limits of muscular exertion. Prof. Hill is also to give two lectures at the Harvard Medical School, and one at the Yale Medical School, and to attend the annual meeting of the American Physiological Society in April. His two predecessors in the visiting lectureship at Cornell have been Prof.

Cohen of Utrecht and Prof. Paneth of Berlin. Prof. Hill expects to return to London at the end of May or beginning of June.

The Secretary of State for Scotland and the Minister of Agriculture and Fisheries have appointed a Wool-Breeding Council "to consider, and advise the Ministry of Agriculture and Fisheries and the Board of Agriculture for Scotland on questions relating to the improvement and utilisation of wool grown in Great Britain." The Council consists of representatives of the Ministry and the Scottish Board, of the woollen and worsted industries, of sheep breeders, and of scientific workers. The last are represented by Prof. A. F. Barker, Dr. S. G. Barker, Dr. F. A. E. Crew, Prof. Cossar Ewart, Sir Robert Greig, Mr. C. C. Hurst, Dr. Thomas Oliver, Prof. R. C. Punnett, Dr. James Ritchie, Prof. J. Lorrain Smith, and Prof. R. G. White. At a preliminary meeting held at Carlisle on Dec. 16, various aspects of sheep-breeding problems were discussed, and it was decided to obtain, as a guide for future breeding, the opinions of manufacturers as to the defects, from their point of view, in wool from the different breeds of sheep in Great Britain, and the directions in which improvement was desired. Preliminary statements were made as to the desirability of instituting certificates for rams with fleeces free from kemp, on lines similar to the certificates now issued for bulls under the Ministry's scheme. It was recommended further that cross-breeding experiments with unstable breeds of merinos should be discouraged, and that grants from public funds should be confined to institutes where there existed suitable facilities for properly controlled and observed breeding experiments.

It is now thirty-seven years ago since the earliest of the 'tube railways'—the City and South London Railway—was opened for traffic. It had an earthed return; that is, the electric current taken by the motors returned to the generators through the earth. When this railway was reconstructed two years ago, an insulated cable was provided for the return current. In an interesting paper by A. R. Cooper on the electrical equipment of the track on the underground railways of London, read to the Institution of Electrical Engineers on Jan. 6, the working results obtained by experience were summarised. In addition, extracts from Acts of Parliament, from the report of Lord Rayleigh's committee on vibration troubles, and from Duddell's reports (1913 and 1914) on sudden pressure rises caused by the accidental earthing of the positive rail, were given. It is generally supposed that the use of the track rails for returning the current is much cheaper than the installation of an insulated fourth rail. This is not necessarily true, as the fourth rail can carry currents for signalling purposes.

One of the most serious troubles in connexion with electric train working is due to ice forming on the conductor rails. Snow does not prevent the 'shoe' from collecting current; the breakdown occurs when there is a film of ice on the rails. This occurs when sleet falls on a rail the temperature of which is below freezing-point. Occasionally oil is fed on to the rails through the collecting shoes, and it is found that this sometimes prevents the ice from adhering. Consistent results, however, have not been obtained. To melt the ice from the rails, very heavy currents flowing for a considerable time have to be used, and so the method of electrically heating the rails is rarely employed. When the atmospheric conditions are such that trouble may be expected, a special car, fitted with steel strip brushes and oil sprays and hauled by a battery car, is used; but this method is not always effective. The loss in weight of conductor rails varies from 0·2 to 1·2 lb. per yard per annum. Mr. Cooper says that, in the interests of safety, it is desirable to change track rails or axles which have been affected by electric burns. He considers also that in the future it is very unlikely that any electric railway will employ the insulated return.

A short time ago the Gassiot Committee of the Royal Society appointed the Astronomer Royal, the Director of the Meteorological Office, and Dr. Chree, to consider what observations of terrestrial magnetism and atmospheric electricity should be made during the eclipse of June 29 next. The sub-committee met on Dec. 16, when the following recommendations were made:—*Terrestrial Magnetism.*—(*a*) That quick runs should be taken on all magnetographs in the British Isles during the period 4 h. to 8 h. G.M.T. on the three days June 28, 29, and 30. (*b*) The vertical force coils at Eskdalemuir and Lerwick should be in action if possible. (*c*) It was considered that field observations and eye observations of magnetic elements are not required. *Atmospheric Electricity.*—(*d*) Where possible the electrographs should be put on to quick run from 4 h. to 8 h. G.M.T. (*e*) As complete a set of eye observations of all elements of atmospheric electricity as can be arranged should be taken during the period 4 h. to 8 h. (*f*) The programme arranged for the day of the eclipse should be carried out on the previous and following days also.

Reports received from the Canadian Department of the Interior and from independent sources tell of the success which has followed the policy of transporting surplus bisons from Wainwright Park to Wood Buffalo Park, which by proclamation of the Governor-General on October 23, 1926, was constituted a Dominion Park with an area of 17,300 sq. miles. This was the sole territory of the only truly wild survivors of the American bison, a distinct species or race, the "wood buffalo," and among these, estimated to number some 1500, have now been dumped plains bisons numbering 1634 in 1925 and approximately 2000 in 1926. From the point of view of the Canadian authorities the experiment has proved a success: they have got rid of a surplus of 3634 plains bisons which were seriously overstocking Wainwright Park, and the transported animals have made good in the much more severe conditions of the North-West Territories. But from the scientific point of view the danger to which reference was made in Nature (Feb. 20, 1926, p. 275) still threatens. While, curiously enough, the 'wood buffalo' has to a large extent simply ignored the imported 'plains buffalo,' and, according to earlier advices received from Canadian correspondents, the two races have tended to segregate into two camps, there has already begun the cross-breeding which was feared, and which, in view of the now overwhelming superiority in numbers of the imported form, may end in modifying or swamping the distinctive characters of the little band of native stock. It may be added here that investigations being carried out by Prof. W. Rowan, of the University of Alberta, suggest that in the skeleton of the 'wood buffalo' there lie differences which clearly mark it off from the 'plains buffalo,' and confirm the distinctiveness of the two species, originally determined by external characters alone.

The second annual report, 1925–1926, of the Imperial Forestry Institute situated at the University of Oxford has been issued. This Institute is still in its first stages of existence, but the report gives evidence of some progress having been made within the past year. The idea underlying the creation of the Institute is to give post-graduate courses to men holding a degree or diploma in forestry and to provide refresher courses to forest officers on leave or who are deputed by their governments. The first object was already provided, we are given to understand, at other universities without any expense falling on the Treasury. The second could equally, and in fact actually was provided, at a university other than Oxford. The University of Cambridge, for example, has maintained that it is capable of conducting instruction up to the standard required. The fine buildings erected at universities outside Oxford, notably Cambridge and Edinburgh, have probably cost something in the neighbourhood of £40,000 and would be worth a far larger sum at the present day. These buildings are equipped for research. It appears from the report that the proposal is now put forward that a sum of £75,000 is to be spent on new buildings to accommodate this new Institute at Oxford. On the face of it the scheme appears to be a laudable one, Nevertheless, it would seem to demand further careful consideration if this money, or the bulk of it, is to be provided from the Treasury. Two points appear to demand a public and unbiassed inquiry before the Government is committed to the scheme; they are: (1) Are not the existing schools of forestry capable of giving all the education required, both up to the degree and post-graduate, and to undertake research? (2) Is it advisable to shut up forestry education in a water-tight compartment?

The resignation of Prof. A. W. Porter from the honorary secretaryship of the Institute of Physics was recently received by the Board of the Institute, and was accepted with great regret. Prof. Porter has been associated with the Institute from its inception, and its growth is largely due to his efforts. Prof. A. O. Rankine, of the Imperial College of Science, has been appointed to succeed him. Mr. Thomas Martin, who has recently held the positions of secretary of the British Empire Exhibition Committee of the Royal Society and of the Optical Convention, 1926, has been appointed secretary of the Institute. He succeeds Mr. G. S. W. Marlow, who has been acting secretary since the death of Mr. F. S. Spiers. The office of the Institute of Physics has been transferred to 1 Lowther Gardens, Exhibition Road, London, S.W.7, and all communications, including those relating to the *Journal of Scientific Instruments*, should now be sent to the new address. A tenancy of the premises to be occupied at 1 Lowther Gardens has been granted to the Institute, on very generous terms, by the Royal Commissioners of 1851; and the Commissioners, in placing this spacious accommodation at the disposal of the Institute, are giving great assistance to its work and to that of its participating societies.

The Air Ministry has issued an official communique giving an account, with full itinerary, of the Cape to Cairo flight of the Royal Air Force in 1925. The flight was composed of four aeroplanes under the leadership of Wing-Commander C. W. H. Pulford. A spare plane was sent to Aboukir, another spare plane and two engines were ready at Kisumu on Lake Victoria, and a third plane and four engines were ready in South Africa. Radio apparatus was not carried on account of its weight, its lack of value in Central Africa, and its demand for a skilled operator. The flight started from Heliopolis on March 1, and returned there from Cape Town on May 27, one day ahead of the time-table. The actual time of flying of the leader's aeroplane was 68 hours 21 minutes on the outward and 72 hours 34 minutes on the homeward journey. The flight was so successful that the account of it is almost devoid of incidents. The aeroplanes and engines proved equally reliable. The only repairs that were necessary were the replacing of one magneto, two airscrews and all the oil tanks. The whole flight of 14,000 miles was done on time in spite of the great range of climates that was traversed. On the return to Egypt the aeroplanes were flown to England.

The Italian National Committee for Geography has decided to raise funds for studies in Palestine. The studies will be mainly geographical, whereas similar institutions already in existence are mainly devoted to historical and archæological research. Some indication of the proposed work is given in the December number of the *Geographical Journal*. The first project to be undertaken will be the charting of the Dead Sea and the mapping of the Jordan trough on a large scale. Geological survey and limnological researches will also be carried out and it is proposed to take observations, over a long period, of changes in the bed of the Dead Sea and the meteorological conditions in the district. Other schemes include the foundation in Jerusalem of a library and collection of maps dealing with Palestine, and the publication of a series of memoirs especially with regard to old cartography, for which much material is available in Italy. The elaboration of the plan and the organisation of the expedition is in the hands of a committee under the chairmanship of Cav. Filippo de Filippi. The expedition is expected to start in November and has the sanction of the British Government and the Governments of Palestine and Transjordania.

To every one who has a receiving set, Pitman's "Radio Year Book" for 1927 will prove of great interest. It contains a great deal of information about British broadcasting and makes attempts to pierce the future. J. Swinburne gives a very characteristic 'pessimistic view' of broadcasting. He points out the fundamental error in the theory of universal education in art, literature, and machine reproduced music. Lavish endowment has little effect on the efficacy of education, or even of research. We can be improved only from the inside. "We cannot become musicians or even musical . . . by sitting with telephones over our ears, or near loud-speakers. No one can be improved, and he can improve himself only by hard work." J. L. Baird tells of the very rapid progress of television, and prophesies that televisors will be on sale before the end of this year. The cover of the book shows a domestic scene of a family gazing at the moving picture of a theatrical performer shown by the televisor and simultaneously hearing the words and music. 'Mentor' states that the day will come when we will be able to sit at home and see the Cup Final or the Derby; or possibly the record of these events will be bottled up and broadcast again during the evening for the benefit of the workers who have no time during the day to sit television gazing. For the last century the monotony of their lives has been driving the country dwellers to the lures and lights of the towns. Will broadcasting and television tend to stop this migration? Prof. J. A. Fleming gives practical details about insulators. He points out that there is considerable surface leakage on porcelain insulators when they are wet, and describes how to make a very simple and efficient insulator to replace them. The wiring of houses for radio reception in several rooms is described. A defect of the system is that any one listening on the telephones in one room will hear most of what is being said in other rooms where there are loud-speakers.

THE new magnetic observatory at Matochkin Shar (Novaya Zemblya), which is associated on the administrative side with the U.S.S.R. Hydrographical Department and on the scientific side with the Central Geophysical Observatory at Pavlovsk, has had considerable recent additions to its equipment. It now operates two sets of Eschenhagen magnetographs, one of higher sensitiveness, with scale values per 1 mm. of 1'·0 for declination (D), 6·6γ for horizontal force (H) and 5·4γ for vertical force (V); the other of lower sensitiveness, 1'·5 for D, 18γ for H, and 14γ for V. The magnetograph house has double walls of wood, and is maintained at a temperature of about 0° C. during the winter. The absolute instruments are housed in a separate pavilion free from iron. They consist of a dip inductor and two magnetometers, one for D, the other for H.

LORD BUCKLAND has promised to contribute a sum of £35,000 in seven annual instalments of £5000 to the National Museum of Wales, Cardiff. The donor has expressed the hope that this will enable the construction of the east wing of the building to be taken in hand. This range of galleries will cost, it is estimated, £46,000, and it is to be expected that Lord Buckland's generous gift will stimulate the growth of a fund which will make possible the completion of the whole of the projected museum buildings.

THE Faraday Society is arranging a general discussion to be held at Oxford on April 22-23 on "The Theory of Strong Electrolytes." The first day of the meeting will be devoted to ionic mobility and the second to the activity of strong electrolytes. In common with earlier discussions of the Faraday Society, the meeting will be distinguished by the presence of well-known scientific workers from the continental countries of Europe, and Great Britain will also be well represented. Accommodation for those attending the meeting is being arranged at Exeter and Lincoln Colleges, and it is hoped to obtain special facilities on the railways.

IN sending his appreciation of the work of Sir J. J. Thomson for our Cavendish Laboratory issue of Dec. 18, Prof. A. Sommerfeld asked that it should be printed in German unless contributions from other men of science abroad were also translated into English. Though we regret that this was not done, as the communications received from the Duc de Broglie, Mme. Curie, and Prof. Langevin were printed in French, yet we can assure Prof. Sommerfeld, who has written to us upon the matter, that no invidious distinction was thereby intended. The fact is that French is more familiar than German to most of our readers, and it was on this account alone that we printed the English translation of Prof. Sommerfeld's note. If contributions had been received in any other language than French, they would have been dealt with in the same way.

A NON-PARTY political literary periodical entitled *The London Weekly* (Price 6*d.*) has recently been started by the Commonwealth Review Ltd., under the editorship of Dr. L. Haden Guest, M.P. The first issue contained an article by Mr. L. S. Amery, Secretary of State for the Colonies, on "A Constructive Empire Policy," which is followed up in the second issue by an article on the same subject by Mr. Philip Snowden. We have also read an informative article by Florence B. Low describing the prospects for British teachers in Canada, while Major A. G. Church contributes an article entitled "Migration." Major Church discusses the migration of peoples within the British Empire, and makes a strong plea for the introduction of the scientific spirit into this problem. Every factor which has any bearing whatsoever on the question must be considered. In conclusion, he remarks that since agriculture is the main industry of the Empire, it is time that a systemic survey of its agricultural resources were made with the view of their proper development.

Imperial Chemical Industries, the great chemical merger formed by the amalgamation of Brunner Mond and Co., Ltd., Nobel Industries, Ltd., the United Alkali Co., Ltd., and the British Dyestuffs Corporation, Ltd., under the chairmanship of Sir Alfred Mond, is to make its first appearance to the public at the British Industries Fair organised by the Department of Overseas Trade at the White City, London, on Feb. 21–Mar. 4, where it will have the largest individual exhibit in the Chemical Section of the Fair. The main object of the exhibit is to make an expression of Imperial Chemical Industries' individuality as one group. It will be Imperial in its significance as showing the wide influence of the company in British commercial affairs. It will be practical in the sense that the man in the street will be able to visualise its numerous activities, and it will be scientific in the sense that the buyer of chemical goods will at once see the intimate relationship which exists between the products made in the factories belonging to the respective component parts of this great organisation.

Applications are invited for the following appointments, on or before the dates mentioned:—A junior technical officer at an Admiralty Experimental Establishment—The Secretary of the Admiralty (C.E. Branch), Whitehall, S.W.1 (Jan. 20). An assistant analyst in the Scientific Research and Experimental Department of the Admiralty—The Secretary to the Admiralty (C.E. Branch), The Admiralty, Whitehall, S.W.1 (Jan. 31). Two demonstrators in agricultural botany in the Department of Botany of the University of Leeds—The Registrar, The University, Leeds (Jan. 31). A director of the laboratories of the Clinical Research Association, Ltd.—The Secretary, Watergate House, York Buildings, Adelphi, W.C.2 (Jan. 31). A professor of anatomy in the University College of South Wales and Monmouthshire—The Registrar, University College, Cardiff (Feb. 26).

Our Astronomical Column.

Recent Sunspot and Magnetic Disturbance.—Several observers noted a spot on the sun's disc seen with the naked eye through the morning mist on Jan. 8. The spot was not an unusually large one, but it is of interest on account of the frequent changes which took place within the stream (of which the leader was the naked-eye object), and also its probable connexion with a magnetic disturbance recorded at Greenwich on Jan. 7 and 8. The most noticeable feature shown by the chief spot was a very bright tongue or 'bridge' which crossed the umbra from south to north on Jan. 3-8. On Jan. 7 this 'bridge' appeared to separate the whole spot nearly completely into two portions. The magnetic disturbance, of moderate intensity, commenced about noon on Jan. 7 and died out at 3 hr. on the following day. The greatest deviation of the declination magnet from its normal position was about 0°·5. The table of important spots for 1927 is continued as follows:

No.	Date on Disc.	Central Meridian Passage.	Latitude.	Area.
2	Jan. 2-14	Jan. 8·5	13° S.	1/1100 of sun's hemisphere.

As regards the sun's general activity, Mr. A. M. Newbegin writes, "Prominences continue active numerically, and metallic outbursts are occurring with much greater frequency, but the big displays of great prominences have not begun yet."

Weather Conditions in Norway for the Eclipse of June 29, 1927.—*Cracow Observatory Circ.*, No. 22, contains a useful note by K. Kordylewski and Z. Eckstein giving cloud-measures for various points in Scandinavia based on many years' observations (32 in some cases). The best conditions are found on the railway from Bergen to Oslo, and at Gällivare in northern Sweden. The cloud-ratio in these regions varies from 5 to 6, 10 being complete cloudiness. Finse has the best ratio, 5·0, and an average of 8 clear days per month. Vardo, in the extreme north of Norway, has the high cloud ratio 7·3, and 3 clear days per month. The experience of the 1896 eclipse in this region was not encouraging.

A New Photographic Star Catalogue.—The catalogues brought out by the Astronomische Gesellschaft, which cover the sky from 81° N. decl. to considerable S. decl., are known to all astronomers. It has now been determined (*Astr. Nach.* No. 5469) to form new photographic catalogues of the region from the North Pole to S. decl. 5°. The plan will be that adopted by Prof. Schlesinger of taking plates 5° × 5° on a scale of 1 mm. to 100″. The objectives will be 4-lens combinations by Zeiss with aperture 206 mm. Pulkovo will photograph the region 90° to 70° N. decl., the remainder being divided between Bergedorf and Bonn. Each observatory will measure its own plates, but the reduction of star places will be done at a single observatory. The re-observation of reference stars is being undertaken by six observatories. The work will begin in 1928, and it is hoped to finish it in three years.

The Distribution of Intensity in Stellar Absorption Lines.—An interesting account of pioneer work in this subject by Miss Payne and Dr. Shapley appears in the *Proceedings of the American Academy of Arts and Sciences* (vol. 61, No. 10) under the above title. A considerable amount of theoretical work has been done on the structure of absorption lines, and practical observations of this kind (which have hitherto been scanty) are of considerable importance. The spectra examined by the authors were all taken with the 16-inch refractor at Harvard, using two objective prisms and a range of different rectangular apertures. These spectra were analysed by a Moll thermo-electric microphotometer, and the intensities, as shown by the photographic tracings, were measured from reference lines (recorded on each tracing) representing 'darkness' and 'clear film.' A line representing the continuous background of the spectrum was drawn in each case by hand across the absorption line tracings, and the intensity drop from continuous background to line was measured graphically for various lines in the spectra of eleven stars. The principal object of this paper is to discuss the method of working and accuracy of the results obtainable. Some results of interest appear, however, even from these preliminary measures of eleven stars. In particular it may be mentioned that, even at the centres of the strong absorption lines of hydrogen and calcium, there is some residual light, of intensity averaging about twenty-five per cent. of the background light.

Research Items.

Sumerian Tablets.—The Manchester Museum has published copies of all of the "Behrens Collection" of Sumerian tablets excepting three, which are defaced and consequently useless. The complete collection contains 50 tablets from Drehem and Umma. The Drehem tablets, eight in number, tally in subject matter with the many others from this site which have been published, and deal with the daily business of Drehem. They contain records of animals for offerings. The Umma tablets belong to the same class, recording the daily details of the administration of animals, barley, and other products, wood, silver, and copper. As these tablets are contemporary, they afford a valuable source of information on Sumerian life and religion, while also serving to check the grammatical and religious texts composed later in Sumerian by authors who were not Sumerians, and when Sumerian had ceased to be the language of the people.

A European Parallel to the Durgāpūja.—Dr. Sten Konow, in the *Journal and Proceedings of the Asiatic Society of Bengal*, N.S., vol. 21, No. 3, argues that although the goddess Kāli is now usually considered to be of non-Aryan origin, there are features in Kāli worship which may point to the existence of an old, not only Aryan, but also Indo-European goddess going back to the time when Indian and European tribes were one people. This view is based upon the account given by Tacitus in the "Germania," ch. xl., of the worship of Nerthus—Mother Earth—by certain German tribes. The features of this worship essential for the purpose of comparison are the position of the priest as the husband of the goddess, the procession and the ablution in a sacred lake. The ceremony may be concluded to be a fertility rite. Various attempts have been made to arrive at a derivation of the name Nerthus. It is rarely used, and Sahlgren has suggested that it is an epithet employed instead of the real name, which was taboo. If so, it should be explained by some feature in the festival, and it is suggested that it is connected with the Sanskrit *Nart*, *Nṛt*, to dance, to act, *i.e.* a description of the symbolic or magic acting in the ceremony. The ideas connected with the base *nṛt* are connected with Siva, the consort of Kāli, the latter, however, playing the more prominent part in the popular fertility rites, she being the great Earth Mother comparable to the chthonic deities and demons of fertility elsewhere. The features of the Durgāpūja in which Kāli is worshipped include days of preparation and feasting, a ceremonial procession, and lastly an immersion in water, which men may not see on penalty of death. The deity comprises the male and female element, thus in herself personating the divine couple represented by the priest and Nerthus in the European parallel.

The Relation of Gonad and Plumage in the Fowl.—Messrs. Pézard, Sand, and Caridroit have demonstrated that in the case of the hen, if the amount of ovarian tissue is sufficiently reduced by operation, the female assumes the plumage characterisation of the male (*C. R. Soc. Biol.*, 92, 566 and 1034, 1924; 93, 1094, 1925; 94, 1074; *C. R. Acad. Sci.*, 177, 1087, 1924). F_1 hens out of a Brown Leghorn ♀ × Faverolle ♂ mating were used. The male plumage assumed was that of the Faverolle. The ovary regenerated, and associated with this increase in ovarian tissue the plumage again became as that of the female, first Brown Leghorn, later Faverolle. The authors argue that these serial changes indicate that the Brown Leghorn type of plumage coloration is a response to a lesser ovarian stimulus than is that of the Faverolle. They conclude that there are racial differences in the threshold of response. Evidence that the conception of differential thresholds of response to gonadic stimulus applied even to individual feathers was also obtained. The occurrence of feathers male on one side of the rachis, female on the other, led the authors to the conclusion that each side of the feather is ambivalent and that it can assume the male or female characters alike, but that the two sides at any given moment during development may not respond similarly to the same stimulus.

Homology of the Ala Temporalis and Alisphenoid Bones.—Dr. Kesteven (*Jour. Anat.*, vol. 61, pt. 1, 1926) discusses at some length the homologies of these bones in the vertebrate series. With regard to the ala temporalis, he concludes that this bone in mammals has been derived from and is homologous with the pila pro-otica of the lower vertebrates. In this conclusion he is in opposition to the views of Broom, which are accepted by Watson, Gregory, and Noble, who regards this bone as a remnant of the palæopterygoid cartilage. As to the alisphenoid bones, the author concludes that they are homologous throughout the whole craniate series. While accepting the views of Gregory and Noble that the so-called epipterygoids of the cynodont reptiles are homologous with the alisphenoid bones of mammals, he denies that they are homologous with the epipterygoids of other reptiles.

Oceanography of the Baltic and Fishery Research.—The current quarterly number of the *Journal du Conseil permanent pour l'exploration de la mer* is mainly devoted to accounts of the water movements in the Baltic and its entrance into the North Sea. Prof. Otto Petterson discusses fluctuations occurring between one year and another in the inflow of the salter North Sea water, which passes in as a bottom current, carrying with it fish of considerable economic importance to the Baltic fisheries. Evidence of long-period fluctuations in the herring fishery is cited, and these are attributed to secular fluctuations in the tide-raising force. Dr. Palmen has applied Bjerknes' circulation theory to hydrographic observations made in the Gulf of Finland, and finds fair agreement between the currents calculated by this means and those observed. The determination of the age of cod from the number of 'winter rings' in its scales has presented difficulties owing to the formation of false rings during an unfavourable period in the life of the fish, such as may be brought about by temporary lack of food. Mr. Graham outlines a method which assists in distinguishing between such false and the true winter ring during the first year's growth, and hopes to extend the application of the method to older fish.

Devonian Volcanic Rocks of New Brunswick.—The *Bull. Geol. Soc. America* of Sept. 30 contains an interesting account by W. V. Howard of the Devonian rocks near Dalhousie, New Brunswick. The volcanic rocks include andesites, dacites, latites, and associated tuffs. Six excellent analyses reveal an unusual richness in soda for rocks of these types, and it may be significant, as the author points out, that some of the pre-Cambrian rocks of New Brunswick and Maine share the same characteristic. Despite this, however, there is no evidence of consanguinity between the Dalhousie volcanics and those of the contemporaneous Aroostook series in Maine. Yet there is a striking resemblance, both mineralogically and chemically, between the rocks of the Dalhousie eruptions and those of the Pentland Hills and other Old Red Sandstone volcanic districts of Scotland. This resemblance extends even to the curious detail that on both sides of the Atlantic the volcanic series of this epoch are free from the great swarms of dykes which are usually found around ancient volcanic centres.

A New Desensitiser for Photographic Plates.—"Jute Red" (or Red 39,651) is a mixture of dyes which dissolves readily in lukewarm water to form a one per cent. reddish-orange solution. It is supplied by the Soc. Anon. des Matières colorantes de St. Denis, of Paris. M. Rene J. Garnotel claims (*British Journal of Photography*, Dec. 17) for it that it has many advantages over previously known desensitisers when applied to either negative or positive emulsions. If the skin or nails get stained by it the colour is entirely removed by a short wash with soap and water. Its aqueous solution (1 part in 5000) replaces some of the water of the developer formula without any risk of the precipitation of any constituent, and this is not only a simpler method of working than the use of a preliminary desensitising bath, but also does not interfere at all with the Watkins' factorial method of development. Formulæ are given for its use with M.Q. developers and for autochromes. The dye is completely eliminated in the ordinary course of washing in all cases.

Menthones and Derived Substances.—A noteworthy advance in the chemistry of the menthones and derived substances is recorded in the Sept. issue of the *Journal of the Chemical Society*. A short while ago Prof. John Read and Miss A. M. R. Cook were successful in isolating a number of pure derivatives of *dl-iso*menthone, starting from the eucalyptus ketone, *dl*-piperitone. They have now extended their operations to the preparation and characterisation of *dl*-menthylamine, *dl-neo*menthylamine and *dl-iso*menthylamine. In a further paper, by Prof. Read and Dr. G. J. Robertson, corresponding derivatives of the pure optically active forms of these bases are described, and a scheme is advanced for representing their relative molecular configurations. Certain striking similarities between the menthylamines and the *iso*-menthylamines are correlated with their closely similar molecular configurations, which differ only in the disposition of the groups about one of the three asymmetric carbon atoms concerned; a parallel relationship is anticipated between the *neo*-menthylamines and the as yet unknown *neo-iso*menthylamines. A new optically inactive menthol is also mentioned by Prof. Read and Miss Cook, and it is likely that additional information on the stereochemical relationships of this important group will be forthcoming as a further consequence of these interesting researches. Incidentally, a fuller knowledge of the chemistry of the terpene group as a whole should result; and it seems that Prof. Read and his assistants have opened up what may prove a very fruitful field of investigation.

Polarisation of Light emitted by Positive Rays.—E. Rupp (*Ann. der Phys.*, No. 22, p. 615, 1926) has recently examined the variation of the polarisation of the light, emitted by a beam of positive rays of decreasing intensity, with the angle at which the beam of positive rays was observed. He dealt with positive rays of hydrogen, helium, and lithium, since these atoms possess the simplest electron structures. The results showed in general that the light polarised with its vector parallel to the beam of positive rays increased in intensity with the angle of vision. When observed in a direction at right angles to the beam, the intensity of the light polarised parallel to the beam was always greater than that of the light polarised at right angles thereto. The variation of the polarisation was greatest for hydrogen positive rays, and was more pronounced for higher velocities of the rays. In the case of helium and lithium rays the variation depended on the spectral series to which the emitted light belonged. Rupp considers that there is probably some connexion between the polarisation of the light emitted by a beam of positive rays of decreasing intensity and the polarised light produced by a beam of parallel electrons which has been studied by Kossel and by Skinner. In fact, the results could be expressed by saying that atoms, moving in a regular manner through an arbitrary arrangement of molecules or electrons, make impacts which result in the emission of polarised light.

Optical Constants of Optical Glass.—The catalogue of optical glass recently issued by the Parsons Optical Glass Company, of Little Chester, Derby, marks an important departure from tradition. The foundations of the usual method of specifying the optical constants of glass date from more than one hundred years ago, when Fraunhofer succeeded (about 1813) in measuring the refractive indices of his telescope glasses for some of the chief dark lines of the solar spectrum. Since that time it has been very usual to achromatise a lens such as a telescope object glass for visual observation by uniting the foci for the C and F lines. Photographic achromatism is usually secured by uniting D and G^1 (the latter being a line of the hydrogen spectrum). The choice of the wave-lengths for achromatism has, however, been periodically discussed, and has been criticised by Gifford and others. Certain conditions for visual achromatism used in optical designing by some workers, such as Conrady, have hitherto necessitated a certain amount of preliminary calculation for the refractive index for "the wave-length of brightest light" in the solar spectrum, approximately $0{\cdot}555\,\mu\mu$, which must be done with the aid of a suitable interpolation formula. Furthermore, the refractive indices hitherto listed have not supplied sufficient indication of the variation of focus with wave-length when achromatism is so established that the minimum focus falls in the regions of shorter wave-length for photographic purposes. This catalogue, following the suggestions of Hasselkus, makes use of five lines in addition to the usual ones, two of helium at $706{\cdot}5\,\mu\mu$ and $587{\cdot}5\,\mu\mu$, and three of mercury at $546{\cdot}1\,\mu\mu$, $435{\cdot}9\,\mu\mu$, and $404{\cdot}7\,\mu\mu$ respectively. The standard refractive indices are listed for the helium line, $587{\cdot}5\,\mu\mu$, which is capable of more satisfactory performance on the refractometer than the double line of sodium. By the aid of this additional information the computer's task should be considerably facilitated, though the mercury green line at $546\,\mu\mu$ is decidedly on the short side of the maximum visual intensity, and a little experience will be needed to make the best use of the additional information. There is little need to direct attention to the wide and useful range of optical glasses now offered; the firm is prepared to make up intermediate types of glass to customers' requirements.

Annual Exhibition of the Physical and Optical Societies.

THE seventeenth annual exhibition of the Physical and Optical Societies was held on Jan. 4, 5, and 6 at the Imperial College of Science, London, and covered a wide range of electrical, optical, and other physical apparatus. This exhibition has rightly come to be regarded as an opportune occasion for the various manufacturing firms to bring to notice their latest improvements, and this year's exhibition reflects great credit on the ingenuity and originality in design and excellence of workmanship of the apparatus shown. There is an atmosphere of courtesy and entertaining informality in these annual events which cannot fail to enhance the interest of the visitors and evoke their admiration. Prof. A. O. Rankine, as secretary, is to be heartily congratulated on his success.

Seventy-four firms exhibited apparatus, and it is regretted that the limited space available in this journal does not permit mention of all the instruments. Reference may be made to the illustrated catalogue of the exhibition for fuller details, and some exhibits embodying new features are noted below.

The attractive lectures in the evenings, and subsections devoted respectively to recent results in physical research, lecture experiments in physics of special interest to teachers, and famous historical physical experiments again appeared in the programme.

The lecture on the first evening was by Prof. E. N. da C. Andrade on light and electricity as it might have been given in 1709 with the apparatus of the time, and, it may be added, under conditions which were dramatically realistic and were greatly appreciated by the audience. The lecturer, who impersonated Francis Hauksbee, and his assistant Mr. Paul, appeared in the picturesque costume of the period, and the hall was appropriately illuminated by candles, which were lighted by flint-and-steel and tinder box. All the experiments were repetitions of those actually performed by Francis Hauksbee, a contemporary of Newton, and were selected as having particular relation to present-day concepts of the electrical constitution of matter. The electric glow accompanying ionisation when matter is finely subdivided *in vacuo* was demonstrated with such simple apparatus as vessels containing oil or mercury and partially evacuated, and then shaken; a mercury jet *in vacuo*; and a rotating glass globe rubbed by the hands. By courtesy of the Royal Society, the actual air pump made and used by Hauksbee was employed in the lecture. This treasured veteran of pioneer apparatus, quaint in design and portraying the combined efforts of wood-turner, joiner, and engineer, was successfully coaxed by Mr. Paul to resume duty after more than two centuries, to the accompaniment of a few merry clanks due to the hand-cut gears, with perfect results.

On the second evening a discourse was given by Dr. C. V. Drysdale on "Progress in Electrical Instrument Design and Construction." Reference was made to the many improvements introduced by Profs. Ayrton and Perry some forty years ago, the more modern improvements being due to the utilisation of new materials possessing properties valuable in instrument design, for example, synthetic resins, chromium gells, and magnetic alloys of the chromium-steel and nickel-iron class. A demonstration was given of the effective magnetic screening afforded by mumetal, and reference was made to the use of this alloy in transformer design on account of its high permeability and low hysteresis. The necessity of studying the bearing of basic formulæ in instrument design was emphasised in the application to d.c. and a.c. instruments and machines, conductors, etc.

The lecture on the third evening was delivered by Mr. J. L. Baird on "Television." The development of this difficult branch of physics was traced from its inception in the early part of the present century down to work done barely twelve months ago. One of the first attempts was a model of the eye comprising sixty-four selenium cells and made in 1906. Later came the single cell in conjunction with an exploring beam produced by vibrating mirrors, then the photo-electric cell replacing the selenium cell; still later the cathode-ray tube was added to the combination of mirrors and cell, and then the rotating prismatic disc replacing the mirrors. A résumé of the lecturer's own research then followed. His apparatus comprises direct current and alternating current motors, lenses spirally arranged on a rotating disc coacting with a slotted disc, and a photo-electric cell, the current variation of which is utilised in the wireless transmission of the image. Reception is effected by similar means. A model of the transmitting portion of the lecturer's original apparatus used in 1925 was on exhibition, and no doubt the bulkiness of the complete plant precluded an actual demonstration. The discourse was repeated the same evening, but one item not referred to in the lecture should be recorded, namely, that Mr. Baird successfully effected the transmission of moving images of human faces at the Royal Institution on Jan. 27, 1926.

The research and experimental section inaugurated at the annual exhibition last year again proved instructive and of special interest in indicating the trend of progress in the application of modern physics to the arts and manufactures. The Research Association of British Rubber and Tyre Manufacturers exhibited a sieving apparatus for the detection and estimation of grit in fine powders by means of wire gauze and a stream of water. The British Research Association for the Woollen and Worsted Industries included in its section a balance for estimating moisture regained by textile materials in drying ovens, an electrical device for controlling room humidity, and a roller setting gauge. The Admiralty Research Laboratory supplied eight exhibits, comprising phonic signalling apparatus, a camera of the revolving-drum type for use with an oscillograph, and other electrical apparatus used in tests involving sonic frequencies. The development of fog-signalling and sound-locating apparatus was illustrated by the Air Defence Experimental Establishment.

Devices for solving practical difficulties continually arising in specialised technical operations were shown by the following firms and institutions: Mr. Conrad Beck, microscope aberration tests; Dr. G. D. Bengough and Mr. J. M. Stewart, protecting and colouring aluminium; the Brown-Firth Research Laboratories, chromium steels; Prof. W. Cramp, a magnetic balance; Mr. H. Dewhurst, a rapid bolometer in operation; The General Electric Co., Ltd., optical and electrical apparatus; Mr. Hallimond, a magnetic separator; W. T. Henley's Telegraph Works Co., Ltd. (Research Dept.), wire and cable testing and phenomena; Metropolitan-Vickers Electrical Co., Ltd. (Research Dept.), valves, electric furnaces, chromium plating, welding, etc.; The National Institute for the Blind; the National Physical Laboratory; and The British Thomson-Houston Co., Ld., together contributed an important collection.

The lecture experiments in physics comprised working models designed to illustrate wireless phenomena; synchronous and induction motors; three-phase currents; wave motion; and magnetic fields. Other apparatus demonstrated cloud experiments, condenser capacity by analogy with models immersed in a solution of copper sulphate, and the rotation of bodies with dielectric surfaces when suspended between the poles of a Wimshurst machine.

In the section devoted to famous historical experiments, Prof. E. V. Appleton exhibited a coil from King's College and used by Joseph Henry in his work on self-induction; Sir Charles Wheatstone's step-by-step telegraph designed in 1840, and a variable resistance box and bridge by the same inventor; and James Clerk Maxwell's model illustrating the induction of currents; while Sir William Bragg exhibited apparatus used by Tyndall in his investigation on so-called spontaneous generation.

Of the almost bewildering assemblage of apparatus, the following exhibits are selected for particular notice: C. Baker, for epidiascopes; The Cambridge Instrument Co., Ltd., an oxygen recorder for boiler feed water, a carbon dioxide recorder for flue gases, a magnetic bridge permeameter, and a glass electrode potentiometer; Crompton and Co., Ltd., their "S.M.S." hygrometer and new wattmeter; W. Edwards and Co., rotary vacuum pumps; Adam Hilger, Ltd., the Guild trichromatic colorimeter and spectrographic apparatus; H. Hughes and Sons, Ltd., echo-sounding gear; Klaxon, Ltd., the 'Audiwave' machine for relieving deafness; Negretti and Zambra, meteorological and electrical appliances; L. Oertling, Ltd., special physical balance with 22 ft. light beam; Ogilvy and Co., dark ground condenser, 1·20 N.A., objectives, and colorimeter; H. Tinsley and Co., electrical and stroboscopic apparatus; and Carl Zeiss (London), Ltd., the "Bitukni" binocular microscope attachment, microscope stand G, Nordenson photographic ophthalmoscope, and direct vision monochromator with wave-length scale.

H. W. H.

The Science Masters' Association.

At the kind invitation of the Vice-Chancellor of the University, the annual meeting of the Science Masters' Association was held at Oxford on Jan. 4-7. The membership of the Association has grown rapidly in the last few years, and at this, the twenty-seventh, annual meeting, some 450 members were present out of a total of 1200. Formal proceedings opened on Tuesday evening, when Brig.-General H. Hartley delivered his presidential address in the large hall of the City of Oxford School. Choosing as his subject the rise and development of the ionic theory, the president gave a masterly survey of both the fundamental work and recent advances, pointing out the way in which the difficulties presented by strong electrolytes are being overcome. To the evident relief of his audience, General Hartley said that practically no change was necessary in the method of teaching elementary work on the theory. On the motion of Sir Richard Gregory, seconded by Mr. H. A. Wootton, a hearty vote of thanks was accorded the president for his address, but much to the disappointment of the Association Prof. H. E. Armstrong, who was present, could not be prevailed upon to speak.

On succeeding days, lectures on various scientific subjects were given by members of the University of Oxford and others, two of the most attractive being that of Prof. E. B. Poulton upon "Protective Mimicry in Insects" and that of Prof. H. H. Turner upon "Eclipses" with special reference to the forthcoming total solar eclipse visible in England. Prof. Poulton's lecture, to judge from the applause it evoked, met with warm appreciation. It was admirably conceived and delivered, and was illustrated with a large number of exquisite lantern slides. We believe it should have been of the greatest value to science teachers, in that it showed how natural history may be made to afford a sound training in scientific method in an extremely attractive way.

The Association was fortunate in securing Prof. Turner's lecture on the total eclipse, not merely on account of the intrinsic value and interest of the lecture, but also because Prof. Turner demonstrated in an inimitable way how difficult astronomical conceptions could be made clear to boys and girls. He captured his audience at once with his small spheres for the earth and moon, indiarubber balloon for Jupiter, and large carriage-umbrella for the sun. After a very lucid description of the causes of eclipses in general, he related the story of several famous examples of the phenomenon, winding up with a graphic account of the Einstein eclipse of 1919. He then described the course of the total eclipse of June next, and urged upon teachers the importance of making arrangements to allow as many of their pupils as possible to see this event, which is likely to prove unique to most Englishmen now alive. Prof. Turner suggested that camps should be formed in suitable spots along the course to accommodate children for the preceding night, and said that he had been in communication with the Board of Education and with the authorities of the Boy Scouts' Association. It is desirable that arrangements should be made some time in advance, and science teachers would do well to lay the matter before their respective headmasters and headmistresses at the earliest opportunity. Fortunately, the date of the eclipse (June 29) does not clash with matriculation, school certificate, or higher certificate examinations, and we therefore hope that the school authorities will view with leniency any alterations in routine which may be necessary.

Through the efforts of the president and of the local secretary, Mr. H. R. Raikes of Exeter College, visits were made to the various colleges, the Bodleian Library, the Clarendon Press, the Morris Works at Cowley, and other places of interest. The wonderful collection of historic scientific instruments at the Old Ashmolean proved very popular, and one heard on every hand the wish expressed that some one would do for Cambridge what Dr. Gunther has done so excellently for Oxford. The collection is rendered additionally valuable by the series of "Old Ashmolean Reprints" now in course of publication, and by Dr. Gunther's small but delightful handbook.

In the Clarendon, electrical, and other laboratories, demonstrations and exhibits had been prepared by members of the University. This feature, which entails a great deal of work on the part of the demonstrators and exhibitors, is always warmly appreciated by members of the Association, who find it of the greatest value as a concentrated refresher course and as a source of new ideas with which to infuse their school lessons.

As in previous years, there was an exhibition of scientific books and apparatus. On the table reserved for books written by members of the Association there were no less than forty-nine exhibits, a number which says much for the enthusiasm and literary energy of our teachers of science. It was pleasing to note that these books were by no means all text-books; some dealt with the history of science, some with science in its more general aspects, and one at least—Dr. I. B. Hart's well-known book on the mechanical investigations of Leonardo da Vinci—was evidence of sound and exacting original research.

The large size of the publishers' exhibit was an unmistakable sign of the importance they attach to this annual meeting. In spite of many counter-attractions, their stalls were always surrounded by crowds of members, and if the keenness of the latter on the latest literature of their subjects is any indication of their educational ability, science teaching in the schools of Great Britain is by no means in the parlous state described intermittently by one or two pessimists. The same interest was shown in the excellent exhibit of scientific apparatus staged by the principal firms; it was clear to an observer that many masters had waited for the exhibition before giving orders for apparatus, and were now busily engaged in spending their grants to the best advantage. The epidiascope, an instrument of incomparable educational value, was a principal focus, and though the price is still too high for a good many schools, we imagine that the makers must have been very well satisfied with the result of their exhibit.

At the business meeting of the Association, held on Thursday morning, the most important step was the alteration of the membership rule to include, under certain conditions, science masters not at present eligible. The chairman, Mr. E. J. Holmyard (Clifton), pointed out that if the Association is to retain control of science teaching in the boys' schools of Great Britain, it is essential that no one doing appropriate work should be ineligible; at the same time, the moment is not opportune for any radical change in the required qualification for membership.

The president and chairman of the Association for 1927 are Sir Thomas Holland and Mr. C. E. Sladden (Eton College) respectively. Before the close of the meeting the members unanimously and enthusiastically asked the chairman to convey a message of congratulation and good wishes to Canon J. M. Wilson, one of the pioneers of science teaching in England and a man whom the whole association holds in affectionate regard. A sympathetic reference was also made to the death of Sir William Tilden, president of the Association in 1904.

At the end of the meeting the chairman, on behalf of the Association, conveyed a very hearty vote of thanks to the Vice-Chancellor of the University of Oxford for the splendid hospitality with which the University had received its members.

University and Educational Intelligence.

St. Andrews.—University College, Dundee, will benefit to the extent of £25,000 under the will of the late William Gibson of Ellieslea, Broughty-Ferry, Dundee. This sum becomes payable on the death of the testator's two sisters, and is to be used to build and equip a laboratory for study and research in pathology and bacteriology.

A course of four free public lectures on "The Total Eclipse of the Sun in June in Northern England" will be given by Mr. A. R. Hincks at Gresham College, Basinghall Street, E.C.2, on Jan. 18, 19, 20, and 21 at 6 o'clock. No tickets will be required.

On and after Jan. 17 a new series of conducted tours will be started for school teachers in the exhibition galleries of the Imperial Institute. Guide lecturers will meet parties of school teachers at 3 p.m. daily, except Saturdays, at the east and west entrances, and conduct them through the various courts, indicating the utilisation and economic value of the various products which are exhibited. It is hoped that teachers will bring at a later date organised parties of school children from their schools and give them practical lessons in economic geography and Empire development in these galleries. Head teachers who wish to send representatives from their schools should make application in writing to the Secretary, Imperial Institute, South Kensington, S.W.7, at least three days in advance. The guide lecturers will also be available to conduct parties of school children at 10 a.m. and 11 a.m. daily, except Saturdays; each party should be limited to about twenty children, accompanied by a teacher. Applications for dates for these tours should be made in the same way to the Secretary, Imperial Institute, South Kensington, S.W.7.

Accredited colleges and universities in the United States are listed in Bulletin 1926, No. 10, of the Bureau of Education. The lists represent, not national governmental approval, for the Bureau makes no attempt to rate or to standardise the collegiate institutions of the country, but recognition by a number of voluntary agencies and by State universities and State departments of education. It is on these lists that all who desire to learn the standing of colleges and universities in the United States must rely for information. A notable step towards the standardisation of the methods employed by these accrediting agencies was taken in 1922 when the American Council on Education, pursuant to the recommendations of a report approved by a conference held in 1921, defined standards for accrediting colleges, junior colleges, and teacher-training institutions. These standards have been adopted in entirety or with certain modifications by the several national and regional associations and by a number of the State departments of education and Church boards of education. Of these associations, the best known outside America is the Association of American Universities. This body has signified its approval of 171 institutions, of which 34 are universities of complex organisation, usually with graduate schools 16 technological institutions, and 121 colleges. These lists are also given in the "Universities Year-book of the British Empire."

The New Education Fellowship (11 Tavistock Square, London, W.C.1) is organising a fourth world conference, to be held at Locarno on August 3-17 next. The general theme of the conference is to be "The True Meaning of Freedom in Education." Among the speakers and group leaders are to be Profs. Bovet of the University of Geneva, Decroly of Brussels, Lombardo-Radice of Rome (editor of *L' Educazione Nazionale*), and Carson Ryan of Swarthmore, the editors of *Das werdende Zeitalter*, Dr. Alfred Adler of Vienna, author of "Individual Psychology," Dr. Adolphe Ferriere, editor of *Pour l'Ère Nouvelle* and founder of the International Bureau of New Schools, and several people actually engaged in the teaching of children. The announcement explains that although much of the conference proceedings will be devoted to problems of the teacher in relation to the child, yet time will be given to the discussion of the personal problems of the teacher, who, it is pointed out, needs to study the art of true freedom; this comes not from unrestraint but from right inner control. The Fellowship aims at discovering the principles of this art both for the child and for the teacher. Time is to be given to investigating the problems of the secondary school and to discussing how far progressive methods can be applied to them without prejudicing examination results. The organisers, mindful of the urgent need of what a contributor to the *Times Educational Supplement* of Dec. 4 calls "a triple alliance" of parents, teachers, and employers, have provided for attention being given not only to the child at the school and in the home but also to post-school problems.

Calendar of Discovery and Invention.

January 16, 1834.—After a voyage of two months from Portsmouth, Sir John Herschel, on Jan. 16, 1834, reached Cape Town. Re-erecting his famous 20-feet telescope at Feldhausen, near the base of Table Mountain, during the next four years he carried out his great survey of the southern hemisphere, observing more than 4000 nebulæ and star clusters, and 2095 double stars. He also made many observations of relative stellar brightness, of Halley's comet, of the satellites of Jupiter, and of sunspots.

January 17, 1783.—Of capital importance in the industrial development of Great Britain were the two inventions of Henry Cort—the rolling mill and the puddling furnace. The former was patented on Jan. 17, 1783, the latter on Feb. 13, 1784. Dudley, the Darbys, Huntsman, and others, had improved the methods of making cast iron and steel, but the main British supply of wrought iron came from Sweden and Russia. Cort's improvements were the results of years of work at his foundry at Fareham, but no sooner had he brought out his invention than misfortune befell him and he was completely ruined. England, however, benefited immensely by his work, and by 1860, just before the Bessemer process was taken up, there were 8000 puddling furnaces in use.

January 17, 1867.—On Dec. 4, 1866, Werner Siemens had written to William Siemens: "I have had a new idea, which in all probability will succeed and may give important results." What that idea was, was disclosed in a paper read to the Berlin Academy of Sciences on Jan. 17, 1867. Werner Siemens then described the first dynamo. In sending the description to his brother for the Royal Society, Werner remarked: "It is successful beyond expectation even in small dimensions. It will be a most important thing." Wheatstone's invention of the dynamo was contemporary, but Werner Siemens was the first to publish particulars of such a machine.

January 18, 1799.—Paper-making is one of the oldest industries, but the first to invent an endless paper-making machine was Louis Robert, an employee of François Didot, of Essones, France. A patent was granted to Robert on Jan. 18, 1799, and in the following years the French Government awarded him 8000 francs. The first machine, however, was made by Hall, of Dartford, and in 1804 the patent was purchased by Henry Fourdrinier, who spent £60,000 on improving it. In England at the present time there are about 260 paper-mills, with a total annual output of 1¼ million tons of paper.

January 20, 1881.—The evolution of the solar system is regarded as one of the most interesting questions presented by modern astronomy, and to this question G. H. Darwin devoted many years of his life. One of his most important papers was read to the Royal Society on Jan. 20, 1881. He showed that in consequence of the effects of tidal friction, the evolution of the earth and moon had been probably unique in the solar system and concluded that as a result of the tides our day and the time of revolution of the moon in its orbit are both lengthening.

January 21, 1795.—During the French Revolution the Committee of Public Welfare took up the matter of education. In September 1794 it was decided "there should be established in Paris a normal school where instruction in the art of teaching science should be given to persons already possessing scientific knowledge." Through this came the foundation of the École Normale, which began its work on Jan. 21, 1795.

E. C. S.

Societies and Academies.

LONDON.

Linnean Society, Dec. 2.—**J. Ramsbottom**: The Society of Amateur Botanists. Mordecai Cubitt Cooke (1825–1914) was appointed head master of the new Trinity School, Lambeth, at the age of twenty-three years. Here he conducted evening botanical classes under the old Science and Art Department. In the later 'fifties he occasionally took his pupils for country rambles. Afterwards they were joined by outsiders, and in 1860 constituted themselves into the Society of Amateur Botanists. This was planned for excursions, interchange of specimens, communication of papers, and the establishment of a library, herbarium, and museum. Cooke was the first and only president. Excursions were held on alternate Saturdays and meetings on alternate Wednesdays. The meetings were held first at the Metropolitan Club, Edgware Road, and then over the shop in Piccadilly of Robert Hardwicke, the publisher of natural history works. A letter in the first volume of *Hardwicke's Science Gossip* (1865) from W. Gibson, suggesting an association of amateur microscopists "something on the plan of the Society of Amateur Botanists," led to the formation of the Quekett Microscopical Club. The new club enrolled 155 members in its first year. Excursions were carried out as with the Society of Amateur Botanists, many of whose members joined the new club. The Society languished and may be said to have been killed by the Quekett.—**C. E. Salmon**: Some interesting British plants. *Myosotis brevifolia* Salm. is a new species, found in marshes in the Cross Fell district, and bearing short, broad, blunt leaves; it produces numerous rooting stolons above ground; its corolla is pale blue, almost as large as that of *M. repens*, the calyx is deeply divided, rather more than half-way, and the segments are oblong, rounded or blunt at the apex; its style is very short. Other plants were also described.

Dec. 16.—**E. Ashby**: Notes on the flora of the Grampian Mountains of Victoria, Australia. The range is situated in Western Victoria, and covers an area of about 60 miles by 30 miles; the rocks are sandstone, with quartzite and intrusive rock in a few places. It forms an ecological islet rising abruptly from hundreds of miles of undulating plains, and is a meeting-place of the east and west as regards its flora. Fifteen species are endemic, including four species of the Leguminous genus Pultenæa, and a terrestrial orchid, *Caladenia iridescens*, which flourishes high up in the barren stony mountain soil.—**W. T. Calman**: The giant teredo. The giant teredo, *Kuphus arenarius* (Linn.), first described by Rumphius two hundred years ago, has hitherto been known chiefly by its massive shelly tube, which may be so much as four feet in length and three inches in diameter at the wider end. A complete specimen was collected by Capt. Burgess, of the Mission steamer *Southern Cross*, in the Solomon Islands. It comprises some thirteen inches of the posterior end of the body, with the siphons and pallets. Instead of boring in wood like the other Teredinidæ, Kuphus lives embedded in the mud of mangrove-swamps, with the siphons projecting from the surface. Possibly it is the full-grown condition of a timber-boring species (perhaps *Teredo mannii*) which is set free by the decay of the wood.—**J. R. Norman**: Ambicoloration and associated variations in flat-fishes. Ambicoloration in flat-fishes is of particular interest on account of the other variations towards symmetry which accompany complete (or almost complete) pigmentation of the blind side. The modification of the scales on the blind side to resemble those of the ocular side in the dab, and the development of bony tubercles on the blind side of the body in the turbot are characteristic variations of this nature. Another correlated variation is the delayed or arrested migration of the eye, which leads to the formation of a characteristic fleshy hook on the head. In the southern flounder of Australia, in which only a single pelvic fin is normally developed, two symmetrical pelvics of equal size are present in completely ambicolorate examples. The tendency is for ambicoloration in flat-fishes to affect the head last of all.

Geological Society, Dec. 15.—**J. H. Davies** and **A. E. Trueman**: A revision of the non-marine lamellibranchs of the Coal Measures, and a discussion of their zonal sequence. The Coal Measure lamellibranchs of the genera Carbonicola, Anthraeomya, and Naiadites are discussed. A description of the sequence in South Wales is given and six zones are recognised. The succession in the north of France is closely comparable with that in South Wales. The relative abundance of the various genera is different, possibly indicating somewhat different conditions of deposition. The sequence in North Staffordshire is also discussed. It is concluded that the lamellibranchs afford a reliable basis for the correlation of the Coal Measures, and especially of that part of the Coal Measures which contains the more important seams.—**L. Merson Davies**: The Ranikot beds of Thal (North-West Frontier Provinces of India). Ranikot beds have never before been known to exist in India outside a very limited area in Sind; the new exposures are at Thal, on the Afghan frontier, more than 500 miles north of any hitherto known of the kind. Many new species, mostly corals, are found in the Thal beds. A particular examination has been made of the foraminifera of the Thal beds. The age of the Ranikot series is pre-Ypresian. The Upper Ranikot may be correlated with the Middle Landenian of Europe, and the Lower Ranikot with the Lowest Landenian and Montian.

DUBLIN.

Royal Dublin Society, November 23.—**H. H. Dixon** and **T. A. Bennet-Clark**: The electrical stimulation of plant tissues. The passage of an electrical current through a tissue leads to a change in electrical resistance and to a change in permeability. The stimulating current used was a sine-wave single-phase alternating current of 50 cycles, of which the voltage was controlled by a potentiometer, and the duration of the stimulus by a pendulum device. Pieces of ivy (*Hedera helix*) leaf, cut 1 cm. square, were used and were found to maintain a nearly constant resistance in the apparatus for so long as three days. A moderate stimulus (say 120 volts for 0·1 sec.) is immediately followed by a very rapid fall in resistance, which becomes less and less rapid, and, after a few minutes, the resistance rises a little and falls again. Finally, it starts to rise slowly, recovering in about an hour to the value it originally had before stimulation. Both a positive and negative deviation of resistance is initiated by the stimulus: their relative magnitudes depend on the magnitude of the stimulus. The smallest possible current causes a response if a certain minimal potential across the membrane is exceeded, and as the stimuli are increased, at first the positive reactions increase the more rapidly and predominate over the negative; with still larger stimuli the negative reactions predominate to an increasingly great extent over the positive reactions, which finally become unnoticeable after very large stimuli. The positive reactions only predominate within a small range of intensities of stimulus, and also only when the energy content of the stimulus is less than 0·01 joule under the conditions of these experiments. With stimuli all of the same energy content, the higher the intensity at which this energy is supplied the more effective it is. The relation between the intensity and the response is S-shaped. In consequence of this it is suggested that a given quantity of energy produces in any cell a definite alteration of resistance whatever the voltage at which it is supplied. It is supposed that the ability of a current to stimulate a cell is determined by the potential difference across the membranes of one cell. A series of stimuli to a single leaf square gives the same response as a single one of the combined duration of the series, provided that the intervals are not too long. We could not detect any conduction of the stimulus from the stimulated zone to any other region of the leaf. Advance of the season and also rise of temperature greatly increased the sensitivity of the tissues; the positive and negative reactions were not affected to the same extent.—**H. P. Lewis**: *Caninia cylindrica* Scouler and other large Caninias from the carboniferous limestone of Ireland.

Royal Irish Academy, November 30.—**J. J. Nolan** and **G. P. de Sachy**: Atmospheric ionisation. The conditions of equilibrium between small ions, nuclei, and large ions in the atmosphere are investigated. It is shown that, when positive and negative large ions are present in equal numbers, the ratio of the concentration of the small ions of the two signs is connected with the ratio of their mobilities by the equation $n_+/n_- = (k_-/k_+)^m$, where m is not far from unity and possibly $= \frac{3}{4}$. For n_+/n_- in atmospheric air the value 1·24 is found. In room air $n_+/n_- = 1{\cdot}11$ and $k_-/k_+ = 1{\cdot}16$. The value of the recombination constants of small ions, positive and negative, with large ions and nuclei are determined. It is found that both small and large atmospheric ions may be resolved into a number of distinct groups.

EDINBURGH.

Royal Society of Edinburgh, December 6.—**H. Graham Cannon** and **Miss S. M. Manton**: On the feeding mechanism of a mysid crustacean (*Hemimysis Lamornae*). This organism feeds on large food masses and on minute suspended particles filtered from the surrounding water. The food stream is produced by the rotary swimming movements of the exopodite of the trunk limbs, aided by a paddle-like action of the maxillary exite. The suspended particles are filtered off by the proximal endite of the maxilla and pushed into the mouth by the combined action of maxillules, maxillæ, and the proximal endite of the first trunk limb. Large food masses are held by the mandibular palps and bitten into by both the incisor processes of the mandibles and by the distal endites of the maxillules. Storch's view that the primitive feeding mechanism of the Crustacea is a filter-feeding process is criticised, and an alternative hypothesis that it resulted from the paddling activities of primitive biramous appendages is put forward.—**J. H. Awbery** and **Ezer Griffiths**: Further experiments with the Ewing ball-and-tube flowmeter. This instrument measures the rate of flow of liquid or gas by the height to which a sphere is carried up a conical glass tube. The results of varying the liquid, the size of the sphere, and the inclination of the meter, have been investigated, and the observations are grouped together by making use of the theory of similitude. There is apparently no simple method of calibrating the instrument for one liquid from the results obtained with another.—**E. A. Baker**: The law of blackening of the photographic plate at low densities. (Second Paper.) iv.—Results for isochromatic and blue-sensitive plates and filtered light. Further low density results are given, and explained on the assumption that the formation of the latent image takes place in two stages, the first being reversible, with the further assumptions that the number of absorbers in a grain is small, and that they are of at least two kinds.—**Frederick Walker**: The igneous geology of Ardsheal Hill. The summit of Ardsheal Hill is an igneous complex formed of a number of rock types of varied composition. The four principal types are kentallenite, appinite, granophyre, and hornblende-porphyrite. In common with other neighbouring intrusions, this complex is probably of Lower Devonian age.

PARIS.

Academy of Sciences, Nov. 29.—**Emile Borel**: A theorem on the linear forms with a symmetrical skew determinant.—**H. Andoyer**: The method of Delaunay.—**Georges Perrier**: The parallel of Meknès (triangulation and levelling).—**P. Villard**: The utilisation of the energy of naturally occurring warm water. Remarks on the subject of the note by G. Claude and P. Boucherot. The energy of hot springs could be more easily utilised in the manner suggested by G. Claude and P. Boucherot than that derived from tropical seas.—**F. Widal** and **M. Laudat**: Study of the modifications brought about in the nitrogen formula of blood serum by renal impermeability. Study of the distribution of the nitrogen compounds in a case of Bright's disease.—**Georges Claude**: The utilisation of the thermal energy of the sea. In January 1923 Tito Romagnoli published a paper on the utilisation of the thermal energy of the deep Italian lakes which to some extent anticipates the recent communication by the author on the same subject. Campbell in 1913 also made similar suggestions.—**G. Sauvageau**: Remarks on a note by Chemin and Legendre on the existence of free iodine in *Falkenbergia Doubletii*. Reply to criticism.—**Krawtchouk**: The distribution of prime numbers.—**Enea Bortolotti**: The angle of two conjugated directions.—**René Garnier**: Plateau's problem.—**V. Smirnoff**: The series of polynomials.—**André Roussel**: The extremum of certain double integrals.—**Podtiaguine**: The theory of growth [of functions].—**H. Galbrun**: Sound waves and zones of silence in the atmosphere.—**Paul Stroobant**: The movement of the whole of the helium stars.—**L. d'Azambuja**. The structure of the solar chromosphere.—**Jarry-Desloges**: Contribution to the study of the planet Mars. During 1926, Mars underwent important superficial modifications, greater than any observed during the preceding twenty years. Details of the observed changes are given.—**Robert Lévi**: The atom in the theory of universal and discontinuous action.—**C. Ledoux**: Method and apparatus for rapidly calculating the point in radiogoniometry.—**Mlle. Paule Collet**: Paramagnetism independent of temperature. Solid potassium permanganate, after purification by numerous recrystallisations, has a paramagnetism independent of the temperature, and this is the same as the salt in solution within the limits of experimental error. This salt forms a third example not in agreement with the law of Curie.—**A. Danjon**: The interferential study of scintillation and the conditions of stability of telescopic images. The diameters of stellar images take, under the effect of atmospheric agitation, values which are independent of the aperture of the objective when the latter exceeds 1 metre. Lord Rayleigh's rule applies to the deformation of images produced by scintillation.—**C. Mihul**: The structure of the third order of spectrum of oxygen.—**D. K. Yovanovitch** and **Mlle. A. Dorabialska**: The calorific effect of the β and γ-rays of radiothorium.—**Mme. E. Tiegler-Soru**: The ultraviolet spectrum of potassium nitrate and its variations as a function of the *p*H.—**E. Raguin**: The tectonic situation of the marbles of flaky structure near the Col de la Leysse (Savoy).—**Yves Milon**: The presence of glaucon in the Vindobonian shell marls of Brittany.—**L. Joleaud**: The tectonic of the Carib regions of South-American Columbia.—**N. Menchikoff**: Geological observations made in the course of the expedition of Prince Kemal-el-Dine Hussein in the Lybian desert (1925–1926).—**L. Blaringhem**: The segregation in mosaic of the fertile hybrids of wheat and barley.—**Jules Amar**: Oxygen-carbon dioxide antagonism. The antagonism of the two principal gases of the blood, oxygen and carbon dioxide, normally conditions the respiratory working. By increasing the proportion of either gas a mechanism of defence can be set up against intoxication by breathlessness, over-fatigue, stuffy atmosphere, and it is a method of treatment of respiratory syncope.—**J. G. Szuman**: The influence of the testicle on metabolism in the Gallinaceae.—**Mme. L. Randoin** and **Mlle. A. Michaux**: Comparative variations in the content of the suprarenal capsules in water, fatty acids, and cholesterol in the normal guinea-pig and in the guinea-pig submitted to a diet minus the antiscorbutic vitamin. The most marked change in the suprarenal capsules of guinea-pigs with experimental scurvy is the continuous fall in the proportion of cholesterol present. The proportion of fatty acids falls at first, but afterwards regains the normal. The water remains constant.—**J. Benoit**: The histophysiological study of the testicular nodules of regeneration in the domestic cock.—**Gilbert Ranson**: The resistance of young *Gryphoea angulata* to heat and their exceptional mortality in 1926.—**Emile André** and **Henri Canal**: The oil of *Mesoplodon bidens*. This oil resembles cachalot oil and oil of *Hyperoodon rostratus*. These three oils form a chemically homogenous group, the composition of which constitutes a marked physiological character of survivors of a fauna now extinct.—**Georges Truffaut** and **N. Bezssonoff**: The conditions which allow of co-operation between nitrogen-fixing bacteria and maize.

ROME.

Royal National Academy of the Lincei, Nov. 7.—**G. Armellini**: The difference between the visual magnitude and the bolometric magnitude of stars in relation to the absolute temperature.—**L. Herrera**: Appearances of struggle and of parasitism with simulations of infusoria. The name "colpoids" is suggested for the infusoria-like preparations made from soap solution and a solution of olive oil in petrol. These colpoids are spherical, elliptical, or of irregular and often ameboid form. Their dimensions vary from 100 to 800 microns or even more, and many of them are visible to the naked eye. Certain of the phenomena accompanying their mutual encounters exhibit very close resemblance to those observed with the struggling and parasitism of living infusoria.—**Alessandro Terracini**: Characterisation of Bianchi's systems of ∞' surfaces.—**E. Raimondi**: Approximate calculation of the dynamic effect of a current flowing between a lamina and an indefinite plane wall.—**Arnaldo Masotti**: Uniform translation of a circular cylinder in a channel with plane parallel edges.—**U. Barbieri**: Astronomical determination of latitude computed at Mondovi in 1925.—**Bianca Nannei**: Cycles of elastic hysteresis in bismuth wires. The cycles followed by the elastic behaviour of steel and iron wires are due principally to a hereditary elastic effect which is gradually dissipated, whereas with bismuth wires they represent a phenomenon of permanent deformation, also distinctly hereditary in character.—**Umberto Crudeli**: Electromagnetic fields having the electric (magnetic) field zero at the circumference and the magnetic (electric) field tangential at the circumference.—**M. Philibert**: Further observations on the apparent duplication of the optic axis of calcite by Federow's plate. This duplication is only apparent and is caused by the anisotropy of the spherical segments of the Federow's plate, which behave like a doubly refracting biaxial substance. Far from being negligible, this double refraction of the segments gave rise to an axial angle of 14° in one case investigated.—**G. Carobbi**: New researches on noteworthy Vesuvian sublimates. Microscopic and crystallographic examination of material from the inner walls of a fumarole situated in a laval canal of the cupola formed on Vesuvius in April-May 1924 reveals the presence of boric acid in the form of sassoline and of potassium fluoborate as avogadrite.—**Guido Cusmano**: New process of dehydrogenation of menthol. When sodium is heated with menthol to about 300°, hydrogen is liberated in abundance and the mass becomes spongy, the sodium mentholate first formed losing hydrogen (2 atoms) to form a sodio-menthone, which again loses hydrogen (4 atoms) to yield sodium thymolate.—**G. Scagliarini** and **G. Tartarini**: Additive compounds of halides of bivalent metals with organic bases (iii). With cobalt and nickel chlorides and cobalt bromide, urotropine forms additive compounds of the form, $CoCl_2$, $C_6H_{12}N_4$.—**Ettore Remotti**: Photo-reactive behaviour in tadpoles and fry fed with thyroid. When tadpoles and the fry of *Salmo lacustris* and *S. irideus* are subjected to treatment with thyroid, their sera undergo important modifications in the colloidal equilibrium, these modifications being attributable partly to increased dispersion.—**Silvio Ranzi**: Investigations on the placodes of Cyclostomi, Ganoidei and Teleostei with respect particularly to the fate of the first epibranchial placode.—**Constantino Gorini**: Behaviour of *Bacterium typhi* in milk. Contrary to the opinion held up to the present, the typhus bacillus is capable of coagulating milk. The mechanism of the change is novel and peculiar and consists of an alkalifying, solubilising phase, followed by an acidifying and coagulating phase. The former phase is preceded by a transitory acidification, the conclusion drawn being that the organism is able to attack lactose, but prefers the casein, which is first proteolysed with production of bases. In the favourable medium thus created, the lactose is decomposed with development of acidity. The passage from the first to the second phase would be characterised by a process of reversion of the casein from the dissolved to the colloidal state.

SYDNEY.

Linnean Society of New South Wales, Oct. 27.—**J. R. Malloch**: Notes on Australian Diptera (ix).—Two genera and ten species are described as new in the families Ephydridæ, Agromyzidæ, Ortalidæ, Sapromyzidæ, Helomyzidæ, Neottiophilidæ and Muscidæ, the new genera belonging to Ortalidæ and Muscidæ.—**Lucy M. Wood**: On some land planarians from Barrington Tops, N.S.W., with descriptions of new species. The collection described comprises six species, representing the three genera Geoplana, Artioposthia and Platydemus, four of the species being regarded as new.—**E. W. Ferguson**: Revision of Australian Syrphidæ (Diptera). Part ii. Subfamily Milesiinæ. Five genera (1 new) and 21 species (10 new) are described. Four species of Graptomyza (subfamily Volucellinæ) are also described, three of them being new.

VIENNA.

Academy of Science, November 18.—**L. Moser** and **A. Brukl**: Determination and separation of the rare metals from other metals (viii.). Determination of thallium as thallium chromate and its separation from other elements. Sulphosalicylic acid is used to separate some metals, potassium cyanide and sodium thiosulphate separate others.—**A. Winkler**: Geological studies in the tertiary region of south-west Styria. Conglomerates and delta deposits.—**R. Seka** and **O. Schmidt**: Amino-derivatives of dinaphthanthracene-diquinone.—**O. Kuhn**: A new hydrozoon from the Jura of Stramberg.—**L. Waldmann**: The geological structure of the Moldau-Danubian primitive rocks on the map sheet Gmünd.—**H. Kupper**: The facies relations of the newer palæozoic in Carinthia. Limestones and the Carboniferous.—**E. Jahoda**: Luminescence and coloration of alkali chlorides when treated with Becquerel rays. A red fluorescence was due to the presence of manganese.

Official Publications Received.

BRITISH AND COLONIAL.

The Deeside Field. (Issued under the Auspices of the Deeside Field Club.) Third number. Edited by J. B. Philip. Pp. vi+88+28 plates. (Aberdeen: D. Wyllie and Son.) 1s. 6d.

Transactions of the Optical Society. Vol. 27, No. 5. Pp. ii+277-336+xiv. (London: Optical Society, Imperial College of Science.) 10s.

Transactions of the Royal Society of Edinburgh. Vol. 55, Part 1, No. 6: The Development of the Hypophysis Cerebri in Man, with a Note upon its Structure in the Human Adult. By Dr. David Waterston. Pp. 123-145+8 plates. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.) 4s.

Proceedings of the Liverpool Geological Society. Session the Sixty-seventh, 1925-1926. Part 3, Vol. 14. Edited by C. B. Travis. Pp. xvi+107-234+3 plates. (Liverpool.)

FOREIGN.

Bulletin of the American Museum of Natural History. Vol. 56, Art. 4: Contribution to the Knowledge of the Fossil Hyracoidea of the Fayûm, Egypt, with Description of several New Species. By H. Matsumoto. Pp. 253-260. (New York City.)

Proceedings of the United States National Museum. Vol. 69, Art. 21: Distributional Notes on some Neotropical Bugs of the Family Nabidæ, with Description of a New Species. By Halbert M. Harris. (No. 2647.) Pp. 4. (Washington, D.C.: Government Printing Office.)

The American Museum of Natural History. Guide Leaflet Series, No. 65. The Art of the Lapidary. By Herbert P. Whitlock. Pp. 29. (New York City.)

CATALOGUES.

Catalogue of B.D.H. Fine Chemical Products, including Organic and Inorganic Chemicals, Analytical Reagents, Indicators, Standard Stains. Pp. 108. (London: The British Drug Houses, Ltd.)

Diary of Societies.

SATURDAY, JANUARY 15.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Neville Hall, Newcastle-upon-Tyne), at 3.—J. S. Carson: Dry Cleaning of Coal.—Paper by L. F. H. Booth, Screening and Washing Plant at Deaf Hill Colliery, open for further discussion.

INSTITUTE OF BRITISH FOUNDRYMEN (Lancashire Branch, Junior Section) (at Manchester College of Technology), at 7.—W. Jolley: My Impressions of American Foundries.

MONDAY, JANUARY 17.

CAMBRIDGE PHILOSOPHICAL SOCIETY (at School of Agriculture, Cambridge), at 4.30.—Prof. T. B. Wood: Animal Calorimetry.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—G. B. Michell: The Comparative Chronology of Ancient Nations in its Bearing on Holy Scripture.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge, Kensington Gore), at 5.—G. S. Laird-Clowes: Ships of Early Explorers.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Circle) (at Armstrong College, Newcastle-upon-Tyne), at 7.—Prof. W. M. Thornton: What is Electricity? (Faraday Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (Tees-Side Sub-Centre) (at Cleveland Technical Institute, Middlesbrough), at 7.—L. C. Grant: Wired Wireless.

INSTITUTION OF AUTOMOBILE ENGINEERS (Scottish Centre) (at Royal Technical College, Glasgow), at 7.30.—A. N. May: Electric Lighting for Public Service Vehicles.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—Award of Prizes and Studentships.

ROYAL SOCIETY OF ARTS, at 8.—Dr. L. C. Martin: Recent Progress in Optics (Cantor Lectures) (1).

HUNTERIAN SOCIETY (at Mansion House), at 9.—Dr. J. M. T. Finney: The Influence of John Hunter on American Surgery.

ROYAL SOCIETY OF MEDICINE (Social Evening), at 9.30.—Prof. A. W. Sheen: Medicine in Ancient Greece.

CHEMICAL INDUSTRY CLUB.

TUESDAY, JANUARY 18.

SOCIETY OF GLASS TECHNOLOGY (at Manchester College of Technology), at 2.30.—Prof. W. E. S. Turner: The Effect of Cullet on the Melting of Glass.—Prof. J. F. Ponomareff: Investigation of the Glassy State by the Method of Forced Crystallisation.—Violet Dimbleby and Prof. W. E. S. Turner: The Durability of Some Soda-Lime Magnesia Glasses.—Prof. W. E. S. Turner and F. Winks: The Thermal Expansions of Some Boric Oxide Containing Glasses.

Royal Institution of Great Britain, at 5.15.—Prof. R. Whytlaw Gray: Smokes as Aerial Disperse Systems (1).

Royal Statistical Society (at Royal Society of Arts), at 5.15.—A. W. Flux: Indices of Industrial Productive Activity.

Mineralogical Society, at 5.30.—Dr. A. Brammall and Dr. H. F. Harwood: The Temperature-range of Formation for Tourmaline, Rutile, Brookite, and Anatase in the Dartmoor Granite.—A. Russell: Notice of an Occurrence of Niccolite and Ullmannite at the Settlingstones Mine, Fourstones, Northumberland, of Stichtite at the Island of Unst, Shetlands; and Serpierite at Ross Island Mine, Killarney, Co. Kerry, Ireland.

Royal Society of Medicine, at 5.30.—General Meeting.

Institution of Electrical Engineers (East Midland Sub-Centre) (at Derby Technical College), at 6.45.—B. M. Chamney: Telephonic Repeaters.

Royal Photographic Society of Great Britain (Kinematograph Group), at 7.—J. B. Pryde-Hughes: The Land of the Magyar.

Hull Chemical and Engineering Society (at Grey Street, Hull), at 7.45.—H. W. C. Henderson: The Lodge-Cottrell Electrical Precipitation Process.

WEDNESDAY, January 19.

Society of Glass Technology (at Grand Hotel, Manchester), at 2.30.—Prof. W. E. S. Turner: The Present Position of the Glass Industry in Germany.—Prof. J. F. Ponomareff: Developments in the Glass Industry in Russia.

Royal Society of Medicine (History of Medicine Section), at 5.—Dr. A. Currie: The Medical History of the First Three Wives of Henry VIII. and their Offspring.—W. R. Dawson: Contributions to the History of Mummification.

Geological Society of London, at 5.30.—L. J. Chubb: The Geology of the Austral or Tubuai Islands (Southern Pacific).—W. Campbell Smith and L. J. Chubb: The Petrology of the Austral or Tubuai Islands (Southern Pacific).

Institution of Civil Engineers, at 6.30.—H. R. J. Burstall: The Testing of Heat Engines.

Institution of Automobile Engineers (Informal Meeting) (at Junior Institution of Engineers), at 7.—Cinema Films of Engineering Interest.

Institution of Electrical Engineers (South Midland Centre) (at Birmingham University), at 7.—A. R. Cooper: Electrical Equipment of Track on the Underground Railways of London.

Institution of Electrical Engineers (Sheffield Sub-Centre) (at Royal Victoria Hotel, Sheffield), at 7.30.—H. B. Yerbury and others: Informal Discussion on The Electricity Bill.

Merseyside Aquarium Society (at 1 Falkland Road, Egremont), at 7.30.—Dr. J. Cotton: Aquatic Insects.

Royal Meteorological Society (Annual General Meeting), at 7.40.—Presentation of Buchan Prize to C. K. M. Douglas.—Sir Gilbert T. Walker: The Atlantic Ocean (Address).

Royal Microscopical Society (Annual Meeting), at 8.—Dr. J. A. Murray: Nuclear Degeneration due to Multipolar Mitosis (Presidential Address).

Royal Society of Arts, at 8.—Sir John Cadman: Development of the Petroleum Industry in Persia.

Folk-Lore Society (at University College), at 8.—Miss Canziani: Folklore of the Abruzzi.

Electroplaters' and Depositors' Technical Society (at Northampton Polytechnic Institute), at 8.15.—H. Sutton: Electrodeposited Coatings for Prevention of Corrosion.

Royal Society of Medicine (Surgery Section), at 8.30.—Dr. J. M. T. Finney: Some Considerations Concerning the Pathology and Treatment of Gastric and Duodenal Ulcers.

Institute of Chemistry (London Section).

THURSDAY, January 20.

Royal Society, at 4.30.—A. Egerton and S. F. Gates: On Detonation of Gaseous Mixtures of Acetylene and of Pentane.—J. Topping and Prof. S. Chapman: On the Form and Energy of Crystalline Sodium Nitrate.—J. Topping: On the Mutual Potential Energy of a Plane Network of Doublets.—W. H. George and H. E. Beckett: The Energy of the Struck String.—*To be read in title only*:—S. R. Milner: An Analysis of the Electro-magnetic Field into Moving Elements.—D. Buchanan: Periodic Orbits of the Second Genus near the Straight-Line Equilibrium Points in the Problem of Three Bodies.—Prof. E. C. C. Baly, R. A. Morton, and R. W. Riding: The Measurement of Absorptive Power.—R. A. Morton and R. W. Riding: Absorption Spectra of Nitrates in the Region 300 μμ.—J. S. Foster: Observed Stark Patterns in Helium.—J. E. Lennard-Jones and B. M. Dent: Some Theoretical Determinations of the Structure of Carbonate Crystals.—Prof. H. T. Barnes: Some Physical Properties of Icebergs: and a Method for their Destruction.—Prof. J. W. McBain and W. B. Lee: Adhesives and Adhesions: True Chemical Compounds as Adhesives.—Prof W. L. Bragg: The Structure of Phenacite, Be_2SiO_4.—H. H. Potter: On the Proportionality of Mass and Weight.—D. M. Y. Sommerville: The Relations connecting the Angle-Sums and Volume of a Polytope of n Dimensions.—P. A. M. Dirac: The Physical Interpretation of the Quantum Dynamics.—Prof. H. M. Macdonald: The Intensity of the Radiation from a Source of Electric Waves, when the Electric Constants of the Medium in the Neighbourhood of the Source are Different from the Electric Constants at a Distance from it.

Royal Institution of Great Britain, at 5.15.—J. R. H. Weaver: Romanesque and Early Pointed Architecture in Spain (1).

Institution of Mining and Metallurgy (at Geological Society), at 5.30.

Institution of Electrical Engineers, at 6.—G. Dunsheath: 33,000-Volt Cables with Metal-sheathed Cores, with special reference to the S.L. Type.

Institution of Automobile Engineers (Graduates' Meeting) (at Watergate House, Adelphi), at 7.30.—J. N. H. Tait: Mixture Distribution in Multi-cylinder Petrol Engines.

Institute of Chemistry (Edinburgh and East of Scotland Section) (jointly with Society of Chemical Industry, Edinburgh and East of Scotland Section) (at 36 York Place, Edinburgh), at 7.30.—Dr. C. H. Lander: The Importance of Fuel Research in the Coal Problem.

Institution of Civil Engineers (Yorkshire Association) (at Hotel Metropole, Leeds), at 7.30.—J. Clemmshaw: The Construction of Sewers in Tunnel.

Chemical Society, at 8.—H. J. Emeléus: The Glow of Arsenic.—H. J. Emeléus and R. H. Purcell: On the Origin of the Spectrum of the Glow of Phosphorus.

Royal Society of Tropical Medicine and Hygiene (at 11 Chandos Street, Cavendish Square), at 8.15.—Prof. J. W. W. Stephens: The Hæmoglobinurias.

Abernethian Society (at St Bartholomew's Hospital).—Prof. W. Blair Bell: Team Work in Research, with Special Reference to the Nature and Treatment of Cancer.

Institution of Mechanical Engineers (Manchester Branch) (at Manchester).—G. Arrowsmith: Steam Turbines.

FRIDAY, January 21.

Royal Society of Medicine (Balneology and Climatology Sections), at 4.—Dr. L. J. Llewellyn and others: Discussion on Climacteric Arthritis.

Royal Society of Arts (Indian Meeting), at 4.30.—H. A. F. Lindsay: Recent Developments in Indian Trade.

Society of Chemical Industry (Liverpool Section) (at Liverpool University), at 6.—Prof. W. C. McC. Lewis: Some Physico-Chemical and Bio-Chemical Aspects of Malignant Growths.

Junior Institution of Engineers, at 6.—Exhibition of Scientific Instruments and Apparatus.

Institution of Mechanical Engineers, at 6.—Prof. A. L. Mellanby and Prof. W. Kerr: Use and Economy of High Pressures in Steam Plant.

Institution of Electrical Engineers (London Students' Section), at 6.15.—H. B. Watton: Automatic Voltage Regulators.

Society of Chemical Industry (Glasgow Section, jointly with Institute of Chemistry) (at 39 Elmbank Crescent, Glasgow), at 7.—J. W. Donaldson: The Volatility and Carbonisation of Oils for Cylinder Lubrication.

Royal Photographic Society of Great Britain (Pictorial Group), at 7.—The Pictorial Aspects of the Lantern Slide.

Geologists' Association (at University College), at 7.30.—Dr. W. G. Shannon: Petrography and Correlation of the Sedimentary Rocks of the Torquay Promontory. Section II.—Permian Rocks.—H. A. Merrett: The Geology of the Lower Valley of the Gade.—W. F. Fleet: The Heavy Minerals of the Keele, Enville, 'Permian' and Lower Triassic Rocks of the Midlands, and the Correlation of these Strata.

Royal Society of Medicine (Obstetrical Section) (jointly with Medico-Legal Society) (at 1 Wimpole Street, W.), at 8.—Dr. J. S. Fairbairn, Lord Riddell, Dr. T. W. Eden, and Sir Travers Humphreys: Discussion on The Ethical, Legal, and Medical Aspects of Abortion.

Royal Society of Medicine (Electro-Therapeutics Section), at 8.30.—Sir Henry Gauvain and others: Discussion on Light Treatment in Surgical Tuberculosis.

Royal Institution of Great Britain, at 9.—Sir William Bragg: Tyndall's Experiments on Magne-Crystallic Action.

Society of Dyers and Colourists (Manchester Section) (at Manchester).—R. S. Horsfall: Modern Industrial Chemistry.

SATURDAY, January 22.

Royal Institution of Great Britain, at 3.—Prof. E. W. Tristram: English Medieval Wall-Painting.

Physiological Society (at National Institute for Medical Research).

PUBLIC LECTURES.

SUNDAY, January 16.

Guildhouse (Eccleston Square), at 3.30.—G. A. de Zoysa: The Soul of Buddhism.

TUESDAY, January 18.

Bedford College for Women, at 5.15.—Dr. R. Campbell Thompson: Conceptions of the Cosmos in Ancient Babylonia.

University College, at 5.30.—Dr. E. G. Richardson: Acoustics of Buildings. (Succeeding Lectures on January 25 and February 1.)

Gresham College, at 6.—A. R. Hicks: The Total Eclipse of the Sun in June in Northern England. (Succeeding Lectures on January 19, 20, and 21.)

WEDNESDAY, January 19.

Institute of Historical Research (University College), at 5.30.—N. B. Jopson: The Prehistoric Relations of the Slavs with their Neighbours. (Succeeding Lecture on January 26.)

University College, at 5.30.—Dr. A. Kihlbom: Modern Sweden: the Land and the People. (Succeeding Lectures on January 26 and February 2.)—Major C. Davenport: The Origin of the Book.

THURSDAY, January 20.

University College, at 5.—Dr. D. T. Harris: The Biological Action of Light. (Succeeding Lectures on January 27 and February 3.)

King's College, at 5.30.—Prof. R. J. S. McDowall: The Mind Physiology.

Northampton Polytechnic Institute, at 7.—R. Genders: Steel and its Thermal Treatment: The Carbon Steels.

SATURDAY, January 22.

Horniman Museum (Forest Hill), at 3.30.—Mrs. H. M. Dunn: Benares, the Sacred City.

SUNDAY, January 23.

Guildhouse (Eccleston Square), at 3.30.—S. N. Mallik: Hinduism.

CONFERENCE.

January 19.

Rothamsted Experimental Station, at 11.30 A.M.—The Culture and Manuring of Sugar Beet:—J. M. Van Bommel Van Vloten: Continental Experience with the Growth of Sugar Beet.—T. G. Fowler: What the Factory wants and how the Farmer can supply it.—L. J. Schapringer: Effect of Climate on the Cultivation of Sugar Beet.—R. N. Dowling: Experiments with Sugar Beet in the Midland Counties.—C. J. Clarke: Practical Experience in South-West England.—H. J. Page and C. Heigham: Manurial Experiments with Sugar Beet at Rothamsted and Woburn.

SATURDAY, JANUARY 22, 1927.

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Schools and Universities.

"On the truth which Science has revealed, and is revealing, we build the new humanism of our age."—Dr. Barnes, Bishop of Birmingham.

RETURNING in 1925 from a world tour, Haber, concerned with the economic plight of Germany, her lack of raw materials, the inconsiderable increase of agricultural efficiency, delivered this message to the German people: "Man kann nämlich den Reichtum nicht nur aus dem Boden holen, sondern auch aus dem menschlichen Verstande." He declared this 'invisible item' of the national balance sheet, the trained human intelligence, to be of vital importance for the resuscitation of his country. He claimed, and rightly, that the German system of higher education has proved more effective than that of any other country in producing men of creative achievement in technical science; they are the geese which lay the golden eggs. That it has not failed in pure science is amply evidenced by the list of Nobel prizemen. He disclaimed any intelligence for his own people higher than in other countries; he attributed the success to the method by which the intelligence has been trained and then utilised, France being inferior in the higher education, England lacking co-operation between university and industry, America being deficient in depth and patience though replete with cash and equipment.

How, indeed, is it with us? In the ten years preceding the War we had made rapid strides in secondary and university education, during the War we envisaged still greater progress, but we chose the policy of the 'knock-out blow' and must wait for the fabric of the vision. Just seven years have slipped away since the Peace Treaty was signed, and we do not yet know whether our ship is slowly sinking or will right herself. Our cousins, over yonder, say we are 'down and out.' They relish exaggeration; yet who can study the events of 1926 and remain blind to the threat that Britain's days as the workshop of the world are numbered? The coal and iron and engineering genius, which together with our coast-line placed us far in the van of industrial development, can keep us there no longer, but our industrial population remains. Trained intellect alone can enable us to hold our own until the transformation of our social organisation shall have been accomplished without catastrophe. Trained intellect—not only, nor even chiefly, trained in technical science. It is true that science furnishes the key to Nature's storehouse of power, that the trained intellect has made man a creator, but of even greater importance is the use he makes of the power and the kind of life he creates. Science is determining the material conditions; the new humanism must rise to the occasion and teach us how to live. Creative thought is what the world is needing in all departments of life; it will express itself in literature and other arts, and it will issue in new hope and energy in all ranks of society. The destiny of Great Britain, and even its immediate future, hang upon the success we can achieve in leading the right men to devote their lives to science, in supplying the needs for their work, and in permeating the nation with a sense of responsibility that the gifts of science shall not be misused.

Great Britain has indeed been exporting much of its 'invisible item' for many years to India and other parts of the globe, carrying the white man's burden. There are obvious signs that this export, like others, will diminish in the near future—no other country has suffered such a drain—and with this leak stopped, the home level may be expected to rise.

No one can doubt that the talent is there. Does any one claim that we make the most of it? The practical problem is beset with difficulties, complexities, incompatibilities. There is no single simple solution possessing all the virtues and omitting none; and time is precious. Ought boys to leave school and approach their university studies fresher in mind? Is too early specialisation in schools a cause of sterility later; and when is *too* early? Is our conception of the university as a sort of examination mill wholly mistaken, if not immoral, and the German plan wholly right, with its freedom from mark-grubbing, and only a *viva voce* on subjects subsidiary to a thesis? And if not absolutely ideal, is it not at any rate more effective in developing the right man and discouraging the rest? The fact is that we are even now engaged on a new synthesis in education, one which bids fair to spare the wheat and straw the chaff. Our national genius is not logical but practical—logic thrives on narrow premises. We have succeeded in producing a multiplicity of types of schools and universities, and rightly used this multiplicity will ease the problem; it may go far to solve it.

The time between educational seed-time and harvest is long, but intensive culture in the last years at school and during the university period may bring forth fruit in a few years. Further, school and university interact rapidly; the effect is like that of the 'reaction' on a radio receiving set, and if judiciously applied the result is harmonious 'amplification,' for the man fresh from the university brings new life back to the schools. Unfortunately, at present the effect of the university on some of the most promising boys is as though the coils were wrongly connected; we get not amplification but *damping*. Many a teacher, not alone the science master, knowing the keenness and capacity of his most brilliant scholars, has felt sick at heart as he noted the effect upon these boys of the enforced repetition of work done years before at school.

The universities do their best to deal with the heterogeneous crowd that presents itself, but the lecturers are frequently overworked and underpaid and are possibly not adequately aware of the thoroughness and high standard of the teaching in many schools. They wearily resist all suggestion of exemption from the first-year courses, or complain that the students are packed with much knowledge but little intelligence. Ought the boys to leave school earlier? Some universities think they ought, and prefer them not to have taken the higher certificate; others regard it as equivalent to their intermediate examination and grant exemption accordingly; some accept it in lieu of the first M.B. if the appropriate subjects are taken, and the reason is a good one, for it is based on the long period of later medical courses.

Obviously the problem of the best development of a *person* is a personal matter, and whenever possible a personal solution should be sought; but schools and universities are institutions, and organisation is paramount. For the purpose of this discussion boys may be divided into the precocious clever and the slow-maturing capable. If the leaving age is eighteen or nineteen, as is usual in the best schools, both types will benefit greatly in character by the sense of responsibility developed in the last year of school life; this would not be very seriously reduced if all boys left a year earlier, for the responsibility would be the same; but if two years were cut off, the boys would not be mature enough and would lose something of great value. Going up to a university at nineteen, the clever boy finds he need not work hard in order to get a good degree, and may seize the wider social and educative opportunities of university life—he may seize them too hard if thwarted in his keenest interest, his life's work; the slower boy, faced by an examination test unsuited to his type, makes inconspicuous progress. If both boys were to go up at seventeen the slow boy would have to work harder for his degree and the clever boy would do well in his examination, but both of them would have two more years to spend at the university free from the warping strain of examinations, free to develop under guidance along lines of natural inclination and innate ability. The fact that the two boys are being compared after the degree examination means that the clever boy has as good a chance as ever of showing what is in him, and the slower maturing boy is being given his chance, at the latest possible academic period and under the most favourable conditions of concentration, to show his capacity. A third plan suggests itself. If nineteen years were adopted as the leaving age, a two-year degree course might be a possibility, ending with an examination, but followed by two more years of post-graduate training of some creative kind and a thesis.

The age at which specialisation should be allowed in schools might also be regarded as dependent on the precocity or otherwise of the boy. On the other hand, it is a matter of experience that the obvious development of the less precocious boy dates from the moment when he was allowed to specialise on a subject of his own choice. The precocious boy is quite usually, though not always, blessed with wide intellectual interests which continue throughout life, and concentration does him no harm. But something more may be required of the university than satisfaction with courses all severely scientific. All science students should be expected to attend at least one course such as philosophy, English literature, and history or economics, preferably in the post-graduate period when their minds will be free to enjoy them, and not for an examination test but for an essay. Similar courses in the sciences might prove of inestimable value for students in arts, if the right men were chosen to create them.

At present, if a student goes up to the university younger than his competitors, he risks getting a poorer degree and making a poorer impression on his teachers, and with it he reduces his chance of post-graduate opportunities. While this remains so, it is scarcely fair to leave the momentous decision to the individual; the handicap is too heavy.

One further point arises. The schools like to keep boys until nineteen years of age. The British type of university does, at least, produce science teachers whose enthusiasm and ability is a great asset to the country. Compared with German universities, where there is almost no routine teaching for degrees by examination and everything is ordered for what we treat as post-graduate work, the science staff of our universities is lamentably small, and the salaries much lower than in the schools. If the universities continue to have to provide instruction, which in Germany is done in the schools, by men who have in addition to master the mass of literature and prosecute research, they will need a corresponding increase of staff or find the task an impossibility. If the schools send their boys at seventeen, then possibly some of the science masters might return to the university with riper teaching experience than the ordinary lecturer can ever hope to acquire; but unless the university authorities cease to override the recommendation of the Treasury Grants Committee, they would do so at heavy pecuniary loss.

The introduction of the Ph.D. degree has created a new situation: the universities must make adequate arrangements for post-graduate work. The crux of the question is the relative value to a man leaving the university at twenty-two years of age, of two more years at school or two years' post-graduate work at the university. Under one system the absorptive sponge may prosper, readily yielding its secreted information under pressure of examinations, but for the development of creative thought the post-graduate years are incomparably more fertile.

The Interior of a Star.

The Internal Constitution of the Stars. By Prof. A. S. Eddington. Pp. viii + 407. (Cambridge: At the University Press, 1926.) 25s. net.

ATTEMPTS to construct theories about the physical conditions inside a star need, of course, no excuse. Such theories are on the same footing as other physical theories, inasmuch as many intermediate steps will be inaccessible to the test of observation. They have, therefore, the right to a fair and serious judgment on a par with ordinary physical theories, according to agreement with observation, inner consistency, or beauty and simplicity.

In his recent book Eddington attempts to give a complete review of current theories concerning the state of things in the stellar interior. This field of theoretical investigations was, in fact, first opened up seriously by Eddington himself not more than ten years ago; and although quite a number of investigators have entered the field since that time, still his own work predominates, and 'Eddington's theory' has become a popular abbreviation for prevailing, and sometimes conflicting, views on this subject.

The growth and development of the theory of matter under stellar conditions has, as might have been expected, run closely parallel to the growth of knowledge about atomic structure. Apart from the point stressed in Eddington's first paper on this subject, namely, that inside a star energy is primarily transferred by radiation, most recent progress in this field is directly traceable to some recent progress in atomic physics. Thus the recognition that the mean molecular weight of matter inside a star may approach a limit in the vicinity of 2 was suggested (by Newall and Jeans) as a direct consequence of the fact known from X-ray experiments that even the most strongly bound electrons may be knocked out of the atoms by suitable stimuli. Eddington's theory of 'white dwarfs' is based directly on the small dimensions of atoms in *K*- or *L*-states predicted by Bohr's theory. The theory of the stellar absorption coefficient, imperfect as it is, was based on recent measurements of X-ray absorption coefficients. When astronomical theory is still groping in the outermost darkness concerning the source of stellar energy, or the origin of the penetrating radiation discovered by Hess and Kolhörster, is it not ultimately because essential facts concerning possible transformations of matter are still out of touch with the technique of the physicists? Eddington's book gives, of course, full recognition to the dependence of astrophysics on physics, and may, just for this reason, cause grief and humiliation to the classical astronomical reader who is out of touch with the modern trend of science in this field.

The general run of the book is as follows. After a short survey of the main features of the problem, both from the observational and from the theoretical side, two chapters are devoted to basic physical theories concerning radiation, atomic structure, and the statistical theory of gaseous assemblies. The fifth and sixth chapters give a thorough discussion of the theory of hydrostatic equilibrium of gaseous stars. In the seventh chapter the theoretical formula connecting the total luminosity of a star with its mass, dimensions, and mean opacity (suitably defined) is calibrated by comparison with observations. The result is that the mean opacity is about constant for stars with the same mass, while it *does* vary for stars with different masses. The relation in question is, therefore, essentially one between luminosity and mass, the dimensions of the star being of no particular concern. The theory thus amplified is, in Chap. viii., applied to different problems concerned with variable stars. The pulsation theory of Cepheid variability is given in full, its odds and ends are looked into; and a similar theory of long-period variability is tentatively suggested.

So far, the constancy and numerical value of the opacity appearing in the mass-luminosity relation has been used as an observational fact. In Chap. x. this question is taken up from the physical point of view, and it is shown how ionisation theory, coupled with almost any reasonable radiation theory, accounts satisfactorily for the observed constancy of the opacity in stars with the same mass as well as for variation with mass. The numerical value of the opacity predicted by theory seems, however, to be decidedly smaller than the observed one, a riddle which is left unsolved by the author. In the tenth chapter several accessory problems are considered, such as the exact degree of ionisation of stellar material, the validity of perfect gas laws, distribution of different elements throughout a star, and the problem of rotation.

The discussion of the delicate question of the source of stellar energy is reserved for the last chapter in the series. There is no doubt that this problem is one of the most urgent in modern astronomy. It seems, however, that we still are remote from an adequate solution, and the author has therefore concentrated his attention on a thorough and open-minded discussion of suggested possibilities, and has not endorsed any hypothesis in particular. This chapter closes the book, as defined by its title. Two chapters on allied subjects are, however, added, one on the theory of stellar spectra, and the other on the state of matter in interstellar space.

The book will doubtless be heartily received, not only by astronomers, but also by physicists as well, many of whom are deeply interested in astronomical problems. It is stimulating reading; not only where one agrees, but also where one does not agree with Eddington. I feel myself in opposition as regards quite a number of (minor) points. Take, for example, the chapter on quantum theory. Here the requirement of reversibility of physical processes in a state of thermal equilibrium, which was established long before the advent of quantum conceptions, is raised to the rank of *Law I.* of quantum theory. In the same chapter a hardy attempt is made, on the basis of this Law I., to construct a new statistical technique, which evidently is intended to supersede ordinary statistical mechanics. Without passing any judgment as regards the failure or not of this attempt, I should much have preferred the use of ordinary statistics in a book intended for the general reader. The statement in § 193 that radiation pressure acts primarily on atoms, not free electrons, seems to me to need further elucidation, especially in view of the statement made in § 147, that "there can be little doubt that the principal process of absorption in the stars is the photo-electric effect." There are other places, too, where I doubt if the statements are adequate to the facts. Further, I have the impression that the book might have been easier and more straightforward reading if less attention were given to theories which might better have been left to a merciful oblivion.

It is no use, however, to dally long over such questions. The book is undoubtedly destined to exercise a great and healthy influence on the scientific activity in this field; and nobody who reads it can fail to feel a deep admiration for the extraordinary flexibility of mind of its author, for his power of going to the root of difficult questions of the most diversified kinds, and for his remarkable ability of expounding his results in intelligible language.

SVEIN ROSSELAND.

The Life of a Nilotic Tribe.

Die Schilluk: Geschichte, Religion und Leben eines Niloten-Stammes. Nach P. Banholzers F.S.C. und eigenen Auszeichnungen dargestellt. Von Wilhelm Hofmayr. (*Anthropos*, Ethnologische Bibliothek: Internationale Sammlung ethnologischen Monographien, Band 2, Heft 5.) Pp. xvi + 521 + 35 Tafeln. (Mödling bei Wien: Verlag der Administration des *Anthropos*, St. Gabriel, 1925.) 20 gold marks.

FATHER HOFMAYR has produced the first monograph on a tribe of the Anglo-Egyptian Sudan, and is therefore to be congratulated. Yet, grateful as ethnologists must be for this volume, the author has distinctly lessened the value of his monograph by limiting the material he has used. So far as the Shilluk themselves are concerned, he seems to have depended for the bulk of his material on the unfinished notes in the journal of the late Father Banholzer; it is true that he has supplemented these by a number of his own observations made between the years 1906 and 1916, as well as those of two other missionaries, Fathers Kohnen and Stang, and added some useful comparative material collected by Father Crazzlara among the Acholi, but he has not availed himself of the material which has appeared during the last few years in *Sudan Notes and Records*; indeed, the reviewer has not noticed any reference to this most useful periodical. These remarks are made in no carping spirit, but are necessary, for in an important work such as this it is advisable that the reader should realise the extent to which omissions are probable. There is no index; only a table of contents.

This said, there can be little but praise for the work. The book is divided into four main parts, the first of which deals with the early wanderings of the ruling stock, and ends with their settlement in their present land under Nyakang—the founder of the Shilluk nation and the first king. Here the most important fact that is brought out is the former existence of a Jur-Shilluk tribe, the people of Dimo, who remained as Jur in their present country, while the adherents of his father's half-brother, Nyakang, followed the latter in his migration. The second part might be called the Book of Royalty, since it treats of the dynasty founded by Nyakang, gives a genealogy of the royal family, examines the reign and chief doings of each king, describes the life of a king from birth, through youth, adolescence, maturity, to death and burial, and ends with a short account of the court language, *i.e.* the vocabulary, not a very copious one, applied especially to the king and his doings. A number of tables of succession are given, three collected by Europeans and four derived from natives; that accepted differs from those previously collected by Banholzer, C. G. Seligman, and Westermann. Chal is given as son and immediate successor of Nyakang, while a queen, Abudok, daughter of Boc (Bwotch), is admitted to the list of reigning sovereigns. This queen was unpopular, her judgment and awards being doubted on account of her sex, and her manner of death is unknown. There are other minor differences, and, considering the authority of Father Hofmayr's native informants, it seems that the list he compiles (p. 42) should be regarded as authoritative and be accepted in future, while the 'queens' of whom the writer heard vaguely in the south can be accounted for as the princesses referred to as chiefs (p. 71). History is considered to begin with the fifth king, Ochalo (Ocwolo), about 1600, but no evidence is adduced for this date, which gives an average of about thirteen years for each reign.

The life and activity of the Shilluk king is dealt with at length, many fresh details being given, but nothing that substantially contradicts earlier accounts. Thus the suggestion put forward by Seligman that the folklore account of the king having at one time to fight for his life actually refers to a former condition is supported by the sham fight, theoretically the first indication of his election, between the king-elect and one of the four 'high chiefs' of the Shilluk country. At Debalo, the first village that the king-elect enters ceremonially, three fires—kindled by friction—are made in front of a large hut which is specially built for the occasion and where the king-elect should spend a month. One of these fires becomes the life-token fire of the new king, and a brand therefrom is carried to the capital—Fashoda. The description of the royal entry into the capital differs but little from that of previous authors. Father Hofmayr, however, has recorded an interesting addition; the king treads on an old man laid bound on the ground for the purpose. According to an account given to the reviewer in 1921, this was substantially a human sacrifice, for the old man was covered with flour paste, and was so betrodden by the multitude that he was expected to die.

The king passes three days in a special hut, and then on the fourth day is carried by the Ororo to Aturwic, his home on the built-up mound at Fashoda; here a further period is spent in retirement. After this the king is for the first time acknowledged throughout the nation. On his first leaving the mound the king is engaged in a sham fight, in which he vanquishes his opponent, and the ceremony is brought to an end with a sacrifice. The chiefs make oration on the rights and duties of the ruler, emphasising their points by brandishing their spears and thrusting them into the ground. The king promises to be a just ruler, to punish wrong, and to protect the weak, and then dismisses the people with an exhortation to remain true to Nyakang and the ancient customs.

A new fact with regard to the king's part in the rain ceremony is that as a last resource, after repeated failure, a man or boy might be sacrificed, and this might also be done for success in war.

The third part of the volume, dealing with religion, begins with a most stimulating discussion of the meaning of the word Jwok (Juok), not only in Shilluk but also in those of the related languages sufficiently well known to permit comparison. So far as the Shilluk are concerned, Jwok is certainly the high-god, the creator, now but little concerned with mankind, but it is noted that disease might be spoken of as *jwok*, though (alternately) each disease has its own name, while in Shilluk folklore men endowed with super-normal powers may also be called Jwok; moreover, the actual practice of sacrifice to benefit a sick man suggests a closer connexion (on this occasion almost a synonymy) of Jwok and ancestral spirits. It may be added that certain spirits of the river and bush of considerable importance among the Acholi (who speak a simplified Shilluk dialect) are recognised by the Shilluk, though among these they have little importance.

The account of Jwok is followed by that of the *ajwogo* (*adjuago*), the 'man of Jwok,' or the 'good medicine-man,' as he has been called, whose actions are, generally speaking, social and beneficent even if they clash with European ideas; it is the *jalyat* who is the 'witch,' the evil medicine-man who by his magic kills people for his own ends, or, more generally, incited thereto as the result of private enmity.

The observations on totemism constitute an important addition to our knowledge. It should, however, be noted that the belief is less obvious, and, apart from exogamy, has less social importance, and is certainly less loaded with effect, than among such frankly totemistic tribes as the Dinka.

The fourth section of the work, entitled "Country and People," contains a deal of heterogeneous information, much of which is new, *e.g.* the political divisions of the country, the greater part of the life-history of the individual (pre-natal to burial), technology, forms of salutations, oaths, stories, riddles, and a most valuable *corpus* of more than 100 songs, providing much material for future analysis. The book concludes with a number of plates and useful technological diagrams.

BRENDA Z. SELIGMAN.

Experimental Embryology.

An Introduction to Experimental Embryology. By G. R. de Beer. Pp. iv + 148. (Oxford: Clarendon Press; London: Oxford University Press, 1926.) 7*s.* 6*d.* net.

MR. DE BEER has written an excellent little book. It is the first attempt in English to survey the field of experimental embryology since the publication of the late J. W. Jenkinson's "Lectures" in 1917, and in the interval much new work has been done. The author does not attempt to include an account of all this work; on the other hand, he has purposely selected from an extensive literature descriptions of those experiments which have a common bearing in elucidating the more essential problems. The consideration of the development and determination of the sexual characters has been deliberately excluded on the ground that this subject has been dealt with recently in works by Goldschmidt and Crew. This is perhaps to be regretted, since some of the best examples of the successful application of the experimental method might have been drawn from recent investigations in this branch of study, and many of them without encroaching on the subject matter of either of the two books referred to. It was inevitable, however, in a work of this size, that the author should select his material, and as it is, he has succeeded in covering a wide field. At the end of the volume is a tabulated list of the experiments cited, with due references to the authors and to the literature.

Mr. de Beer begins by pointing out the relation between descriptive and experimental embryology; in so doing he might have added that the relation is essentially the same as that between descriptive and experimental physiology. Embryology, like descriptive physiology, differs from morphology in the introduction of the time factor; that is to say, it deals with sequences of events. The study of the processes of salivary secretion or the œstrous cycle can be undertaken without recourse to experiments (unless the killing of the animal at a particular stage of activity be held to involve an experiment) in just the same kind of way as the tracing of the progress of development. But it is only by the use of the experimental method that we can study the mechanism of the secretion and the nature of the stimulus which produces it, or the interaction of the ovaries and the other organs concerned in accounting for the œstrous cycle. The subject of this book, therefore, is the experimental physiology of the developing animal.

After a chapter on fertilisation, in which Lillie's theory is duly set forth, the author proceeds to the consideration of parthenogenesis and the factors which activate the egg. The evidence from experiments on larval hybridisation is then separately discussed, and it is shown that the activating effect of the sperm can be distinguished from its hereditary effect. Sections follow on the relation between the sizes of nucleus and cytoplasm and the value of the chromosomes. Unlike a recent reviewer in NATURE (June 5, 1926, p. 781), the author adopts the view (in our opinion with justification) that the chromosomes are the bearers of the hereditary characters, and he points out further that experimental embryology provides evidence that each chromosome of the sets brought in by the nuclei of the sperm and ovum has a particular and essential part to play.

The next four chapters are on cleavage, and the internal and external factors in development are then discussed. There are admirable summaries of the important work of Child on 'axial gradients' in the rate of metabolism of the tissues, and that of Spemann and others on differentiation and the reverse process of reduction. The latter occurs normally in the resorption of the amphibian tail, or abnormally by starvation, as with the planarian. The self-regulating power of the organism is discussed under the head of 'regeneration,' as well as in a later chapter. The action of hormones as factors in development is illustrated by the part played by the thyroid in amphibian metamorphosis, and it is shown that the 'all-or-none' law, which Lipschütz has sought to apply to the working of another hormone, does not hold here. In the next chapter the author deals with the relation of nerve to muscle in embryonic growth. Finally, there is a brief review of development, in which certain general principles are discussed.

The author does well to remind us that "with regard to the term 'explanation' . . . ultimately nothing can be really explained." He might have elucidated the matter further by saying that the term is used in science to denote the process of co-ordination of facts whereby these can be brought under general schemes or laws which enable us to generalise and to predict. A distinguished physicist is reported to have said that a law of Nature is not a statement of fact but of policy. The test of the soundness of the policy or the validity of the law is that the events we expect are the events which come about. The author of the book under review is not certain whether the processes that go on in the living organism can be satisfactorily interpreted on a physico-chemical basis or whether they may "require non-physical categories to contain them." It is clear that the conceptions he employs as to the self-regulating capacity belong to teleological categories, like those relating to 'compensatory hypertrophy' in the physiological text-books. The only test of the validity of such conceptions is whether they enable us to advance our science by generalisation and prediction. If they do this, they reflect recognisable degrees of reality.

F. H. A. MARSHALL.

British Aphides.

The Plant Lice or Aphididæ of Great Britain. By Fred. V. Theobald. Vol. 1. Pp. ix + 372. (London: Headley Bros., 1926.) 25s.

IT is fifty years since the first volume of Buckton's monograph on British aphides was published. Since that time, plant lice have been widely studied in Europe and America, and more recently in

Japan and other countries. Mr. Theobald has studied the aphides of Britain for some thirty years, and has published numerous papers on them from time to time. Every one interested in insects, particularly economic entomologists, will welcome, therefore, the publication of this up-to-date monograph, based on the author's extensive studies.

The classification adopted follows closely that of Baker (1920), which is certainly the most rational and logical one in existence. It is proposed to deal only with the family Aphididæ, and this first volume is concerned with the sub-tribes Macrosiphina and Pentalonina. Fourteen genera and 133 species are recognised, and in addition four other species are noted in the appendix. Descriptions of the parthenogenetic females of the species together with keys are given, the salient external features being figured. In addition, notes on synonymy, food plants, localities and biology are added. The sexuales are unknown in many species of aphides, and it is surprising that in only nineteen of the above species are both sexual forms described in this volume. In five other species the male only is described, and in five further cases the sexual female only is described. It is not clear whether we are to conclude that the sexuales are unknown in all the other species, or whether they are omitted in some cases because they do not require special notice. For example, on p. 216 the apterous oviparous female of *Rs. ligustri* is stated to be abundant, but it is not described. Similarly, on p. 14 the sexual female of *C. rosarum* is referred to, but no description of it is given under that species.

A useful introductory chapter gives an account of the general morphological and biological features of the Aphididæ. The statement on p. 6: "The rostrum was formerly looked upon as the labium, but it is really an extension of the body," requires further explanation; the available embryological evidence indicates that the rostrum in Rhynchota is labial in origin. The old nomenclature for the wing veins is used. One feels it might have been better to have adopted the nomenclature of the Comstock and Needham system, as Patch has worked out the homologies in aphides.

Two misprints not included in the errata have been noted: the genus Aphidiella should read Aphidella; the specific name *M. scropulariæ* should read *scrophulariæ*.

Entomologists owe a great debt of gratitude to the author for the laborious task he has so faithfully carried through, and will look forward to the early publication of further volumes. J. D.

Our Bookshelf.

A Nineteenth-Century Teacher: John Henry Bridges, M.B., F.R.C.P., sometime Fellow of Oriel College, Oxford, and late Medical Inspector to the Local Government Board. By his Niece, Susan Liveing. Pp. xv + 262. (London: Kegan Paul and Co., Ltd., 1926.) 7*s.* 6*d.* net.

DR. J. H. BRIDGES was the most philosophic and scientific mind among the leaders of the positivist movement at the end of the last century, and it is good to know that he will at last be recalled to mind, while many who knew him in person are still alive. For he was unique in many ways, a most attractive and lovable character, above all a thoroughly typical Englishman who had succeeded in putting himself in the right European and international position without forfeiting a jot of his national qualities and attachment. He became, by his training at Oxford and as a doctor and by his attachment to Comte, the most all-round man of his time, specially interesting to readers of NATURE and contemporary men of science generally.

After taking the ordinary course of 'Literae Humaniores' at Wadham, Dr. Bridges qualified himself thoroughly as a physician, and throughout his life kept the balance true between scientific and literary and historical studies. Had he not been preoccupied with the organisation of the Poor Law infirmaries of London, there can be no doubt but that he would have contributed largely to historical writing of the type now so much needed, namely, synthetic history, in which the due place of scientific thinking in building up the social structure is duly recognised and maintained. As it was, he wrote a number of valuable short studies, of which Mrs. Liveing gives a useful list. Apart from its success as a personal portrait, her book is well worth getting for its inimitable picture of the life in the evangelical parsonage where Bridges spent his youth, and to which he always turned back with affectionate memories in spite of his later developments. One must read the literal account of all this in Mrs. Liveing's authentic narrative before one can believe it, and it would be a pity to spoil the enjoyment of this or of the delightful figure of his mother by quoting any fragments. The whole is the best recent biography which has appeared, sympathetic, well-balanced, sufficiently detailed, and not too long. It gains much in value by the extremely interesting study of positivism and science by Prof. Patrick Geddes.

F. S. M.

Tafeln zur Bestimmung des Wasserdampfgehaltes der Luft mittelst eines Haarhygrometers und Thermometers gerechnet und erläutert. Von Dr. J. N. Dörr. *Anleitung zur Behandlung eines Haarhygrometers und zur Verwertung fur die lokale Wettervorhersage.* Von Dr. A. Schlein. (Wien: Selbstverlag von Dr. A. Schlein, 1925.) n.p.

THESE tables have been prepared for use in place of a similar set of tables by Perntner, which were printed as an appendix to Jelinek's "Psychrometertafeln." They are issued by the Austrian Central Institute for Meteorology and Dynamics for use at Austrian meteorological stations. The tables give vapour pressure in millimetres in terms of the two arguments, dry-bulb temperature and relative humidity, the latter to be observed by means of the hair hygrometer. In a general discussion of the question of measurement of humidity, Dr. Schlein recommends the use of the hair hygrometer in preference to other methods, quoting a statement by Pircher that the indications of the hair hygrometer are independent of the air-pressure and of wind velocity. He also quotes a remark made by de Saussure in 1783: "When all other possible hygrometers have been tried, one will always fall back on the hair hygrometer."

There is a brief account of the precautions necessary to obtain accurate results by the use of Lambrecht's polymeter, which appears to be the standard type of instrument used by the Austrian service. This is followed by some remarks on the use of the readings in local forecasting, particularly forecasting of frost. A conversion table is given for converting pressure in millimetres to millibars. The discussion by Dr. Schlein will be read with interest by all who are interested in questions of humidity.

The tables, which were prepared by Dr. Dörr, are printed in a very clear and convenient form, and will doubtless be regarded as the standard tables for use when relative humidity is observed directly.

Primitive Trade: its Psychology and Economics. By Prof. Elizabeth Ellis Hoyt. Pp. vi + 191. (London: Kegan Paul and Co., Ltd., 1926.) 7*s*. 6*d*. net.

If it were necessary to classify Miss Hoyt's "Primitive Trade" as anthropological, economic, social, or psychological science, it would be difficult to assign it to its proper category, for it belongs to all. It is essentially a study of values, and all the various influences, social, religious, customary, and personal, which can be held to bear in determining values have been brought into the account. Miss Hoyt visualises the central problem of economics as a study of the attempt to arrive at a 'perfect price.' This involves a full satisfaction of needs, while how it is to be attained necessitates a study of the underlying psychological processes and their development. This in turn is dependent upon a survey of the facts—the data provided by the anthropologist showing what people actually do at various stages of culture when they fix 'price' either explicitly or implicitly. She begins with the consideration of interests and passes on to the objectifying of needs, and shows how these interact and are brought into operation in the beginnings and extension of trade. Miss Hoyt has clearly been strongly influenced by Dr. Malinowski's studies of primitive trade and economic conditions in the Trobriands, which demonstrated clearly that in determining the factors of value, we must extend our vision far beyond the vistas of the economist of the schools. Her treatise is a stimulating and really original contribution to the literature of economic science.

Microscopic Fresh-Water Life. By F. J. W. Plaskitt. Pp. xi + 278 + 14 plates. (London: Chapman and Hall, Ltd., 1926.) 13*s*. 6*d*. net.

It is with regret that one learns of the sudden death of the author of this book almost immediately after its publication. But though the author has passed away, his book remains, and sentimental considerations must not prevent a reviewer from giving a plain statement of his impression of it. The book is meant primarily to assist the beginner and to instil into him some enthusiasm for that most fascinating of hobbies, the study of pond life. In his desire to popularise this subject, the author has certainly written a very attractive and interesting book. He had considerable experience of the subject, and has therefore been able to give much valuable information on the habitat and the best method of collecting fresh-water organisms. Both animals and plants are treated very fully. Most of the illustrations are admirable, and there are a great many remarkably fine photo-micrographs, the majority of which are taken with dark-ground illumination.

There is a useful glossary at the beginning of the book, and a really valuable chapter has been written by Mr. Chas. D. Soar on Hydracarina.

Unfortunately, the book contains much that is both incorrect and unscientifically written. A list of a few such blemishes has been sent to the publishers.

A. G. L.

Riemannian Geometry. By Prof. L. P. Eisenhart. Pp. vii + 262. (Princeton: Princeton University Press; London: Oxford University Press, 1926.) 13*s*. 6*d*. net.

The recent physical interpretation of intrinsic differential geometry of spaces has stimulated the study of this subject. Riemann proposed the generalisation, to spaces of any order, of Gauss's theory of surfaces, and introduced certain fundamental ideas in this general theory. Bianchi, Beltrami, and others made substantial contributions to the subject, which was extended by Ricci with the use of tensor analysis and his absolute calculus. Recently there has been an extensive study and development of Riemannian geometry, and the book before us aims at presenting the existing theory.

The first chapter contains an exposition of tensor analysis sufficient for the reader who has not previously studied this subject. Most of the contributors to the theory of Riemannian geometry have limited their investigations to spaces with a metric defined by a positive quadratic differential form. The theory of relativity, however, deals with spaces with an indefinite fundamental form, and the former restriction is not made in the present book. Although many results in the older theory have been modified to meet the demands of relativity, much remains to be done in the unrestricted field.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Thermodynamic Diagrams in the Study of the Upper Air.

SOME months ago a letter appeared in NATURE (November 14, 1925, vol. 116, p. 709) from Mr. J. S. Dines, directing attention to the usefulness of setting out the results of the observations of pressure, temperature, and humidity in the upper air upon a diagram in which temperature and entropy are the co-ordinates, entropy and the logarithm of potential temperature being convertible terms so far as the atmosphere is concerned.

Circumstances have led me to pay further attention to that subject, and I find that the diagrams may be very useful in other ways, especially as a means of evaluating the height of an ascent.

Curiously enough, the most direct avenue to the determination of the height of a point is a previous determination of the geopotential at the point—by geopotential is to be understood the work which would be required to lift unit mass, a gram of balloon, for example, or in England, I suppose, a pound of aeroplane, against gravity to the level of the point.

A very simple calculation shows that if the graph of the ascent be set out on an entropy-temperature diagram, which involves no observations except those of pressure and the corresponding temperatures —the primary observations in all soundings or height measurements of the upper air—the geopotential difference between the start and the finish (or any other point on the graph) is made up of two terms. The first is the work done by unit mass in describing the graph, which is in fact proportional to the area that lies between the graph on the left, the vertical of absolute zero on the right, and the two horizontal lines of equal entropy, top and bottom. This sounds very alarming, but on the diagram it only means running a planimeter round an area. The second term is proportional to the temperature difference between start and finish, and is, in fact, proportional to the difference of *pv* for unit mass between the start and the finish.

Expressed otherwise, the first term is the dynamical equivalent of the heat which must be supplied to the ascending unit to keep it in thermal equilibrium with its environment throughout its journey; and the second term is the equivalent of the heat taken from the ascending unit itself in consequence of the reduction of its temperature.

With a planimeter one can allow for all the sinuosities of the graph, an allowance which, so far as I know, is not made in ordinary practice when evaluating the height from the trace of a meteorograph.

The calculation is thus simple enough, in spite of the forbidding words used in connexion with it; and it can be verified by making a graph for the ascent, referred to pressure and temperature, with pressure on a logarithmic scale and temperature linear. Again it is only the measurement of an area on the paper.

The step from the geopotential thus computed to height in the ordinary sense is the simple one of using a conversion table. The process is much simpler than the other way round, because the variable *g* only comes into the conversion table.

I refer to these methods for a special reason. Prof. V. Bjerknes and others insist upon the propriety of using 'levels' (expressed numerically as geopotential) instead of ordinary heights in all dynamical study of the atmosphere; and, without a consciousness of special pleading, it is scarcely possible to resist their contention.

The ordinary exculpation for using heights instead of 'levels' is that we compute heights that one can see; and altimeters, for example, are graduated in heights; but when we find that it is really 'levels' that are easy to calculate and come directly from our curves by so simple a process as measuring an area, we may think it worth while, not only in meteorology but in aeronautics also, to learn to think and talk and work in levels and not in the customary but more complicated dynamical conception of heights.

NAPIER SHAW.

10 Moreton Gardens, S.W.5,
Dec. 14.

The β Bands of Nitric Oxide.

As has been shown by the work of E. P. Lewis and of Strutt and Fowler, the spectrum of active nitrogen consists of three systems of bands (α, β, and γ bands of Strutt and Fowler), of which only the α bands (part of the first positive nitrogen bands) appear if oxygen is carefully excluded. The investigations of Lewis, and later those of Strutt, indicated that the γ bands (third positive nitrogen bands) and β bands are both due to the presence of small amounts of oxygen as nitric oxide. Dr. H. Sponer has recently shown (Sponer, NATURE, 117, p. 81, Jan. 16, 1926, and Sponer and Hopfield, *Phys. Rev.*, **27**, 640, 1926) that this is certainly true, and that the β and γ systems have a common final state which is the normal state of NO. This is in agreement with the calculations of Birge and of Mulliken, which indicated that, with a certain assignment of quantum numbers, the vibrational constants for the final state are identical in the two systems. In a recent paper in the *Philosophical Magazine* (Sept. 1926, p. 621), Dr. R. C. Johnson and Mr. H. G. Jenkins give equations for the frequencies of the β system heads in terms of the vibrational quantum numbers. The proper assignment of quantum numbers was self-evident after the common final state of the β and γ bands had been recognised.

The β bands were first observed by Lewis in 1899 while studying the nitrogen afterglow. These bands were later measured and arranged in Deslandres' progressions by Fowler and Strutt, using photographs obtained with a quartz spectrograph. We have now photographed the bands in the second order of the 21-foot concave grating at Harvard University, using as a source active nitrogen to which enough air had been added to quench completely the α bands. Practically all of the β bands hitherto reported appear on our plates, and we have undertaken a comprehensive analysis of the system.

It has recently been shown (cf. R. T. Birge, NATURE, Feb. 27, 1926; R. S. Mulliken, *Phys. Rev.*, Nov. 1925 and Sept. 1926) that the electronic states of many molecules show a close parallelism to those of certain corresponding atoms. In particular, these analogies indicate that the NO molecule should have a doublet *P* (^2P) normal state like the aluminium atom. Assuming that the γ bands correspond to a $^2S \longrightarrow {}^2P$ transition in NO (cf. Mulliken, *l.c.*, and *Phys. Rev.*, Dec. 1926), the observed doublet separation $\Delta\nu$ of 122 wave-number units for these bands should represent the separation between the $^2P_1$ and $^2P_2$ sub-levels of the ^2P normal state. Now the β bands also show a double electronic frequency for which, according to our analysis, $\Delta\nu = 91{\cdot}05$. Assuming identity of the final states of the β and γ bands, we may reasonably conclude that this $\Delta\nu$ represents the difference between an electronic doublet separation $\Delta\nu = 31$ for the initial state of the β bands and the separation $\Delta\nu = 122$ of the final state. The relations just discussed are illustrated in Fig. 1 (the energy levels are not drawn to scale).

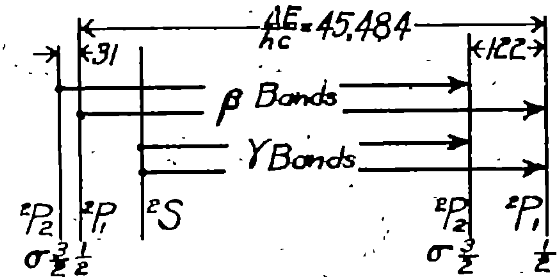
$\frac{\Delta E}{hc} = 45{,}484$
31
122
β Bands
γ Bands
$^2P_2$
$^2P_1$
^2S
$^2P_2$
$^2P_1$
σ $\frac{3}{2}$ $\frac{1}{2}$
σ $\frac{3}{2}$ $\frac{1}{2}$

Fig. 1.

Each of the two heads, in each β band, corresponds to a series of lines which constitutes a P and an R branch of the ordinary type, except that in the high-frequency sub-band *two* lines are missing in the otherwise continuous series, and *four* in the low-frequency sub-band. Quantum analysis shows that each complete band involves four distinct sets of rotational levels, two initial and two final, *i.e.* one set for each of the four electronic states above assumed. The analysis shows further that the rotational quantum numbers are *integral* in all four cases if the rotational terms are of the form $B(j^2 - \sigma^2) + \ldots$ The missing lines then correspond to the rotational transitions $0 \rightarrow 1$ and $1 \rightarrow 0$ in the high-frequency, and to $0 \rightarrow 1$, $1 \rightarrow 0$, $1 \rightarrow 2$, and $2 \rightarrow 1$ in the low-frequency bands. They are completely accounted for by $\sigma = \frac{1}{2}$ (for both initial and final states) in the high-frequency and $\sigma = 1\frac{1}{2}$ in the low-frequency sub-bands, since j is necessarily limited to values equal to or greater than σ. Here σ is an electronic quantum number; $\sigma h/2\pi$ is the resultant electronic angular momentum of the molecule, which is here directed along the internuclear axis. The high-frequency bands then correspond to a transition $^2P_1 \rightarrow {}^2P_1$ and the low-frequency bands to a $^2P_2 \rightarrow {}^2P_2$ transition. This interpretation is completely in harmony with the generalisations of one of the writers (Mulliken, *l.c.*) in regard to j and σ values, etc., in odd and even molecules.

The above description requires slight modification in that the lines of the higher frequency bands are very close doublets, the separation of which is apparently proportional to j. They begin to be resolved, on our plates, at about $j = 16$, where the separation is 0·24 wave-number units. This shows that the rotational levels in one, or both, of the $^2P_1$ states are double.

Intensity relations among the band lines give strong support to the above interpretation. For the intensity I of any line, one expects $I = ie^{-E/kT}$, where E' is the energy of the initial state, T the absolute temperature, and i a probability coefficient. The observed intensities of the P and R branches rise to a maximum and then fall, the distribution being almost completely symmetrical in the two branches, as in the CuH and HCl bands. For high j values, however, the P branch is somewhat the stronger, as would be expected due to the factor $e^{-E/kT}$. At first sight the bands appeared to contain only P and R branches, but on careful inspection a very weak Q branch was found in each band, with the intensity *decreasing steadily* from the first line. The Q branch is much weaker for the higher frequency ($^2P_1$) than for the lower frequency ($^2P_2$) bands. In the former the first line is fainter than the first lines in the P and R branches, but in the latter it is somewhat stronger. All the above intensity relations are in exact accord with the intensity formulæ (for the i values in the equation above) deduced with the aid of the summation rule by Hönl and London (*Zs. für Physik*, vol. 33, p. 803, 1925) for the case where the electron transition involves no change in σ. Even the particular values $\frac{1}{2}$ and $1\frac{1}{2}$ for σ are definitely justified by the observed intensities in the Q branches (according to Hönl and London's equations the intensities of the Q lines should be approximately proportional to σ^2/j).

Preliminary values for the moment of inertia and internuclear distance in NO have been calculated. In the initial states the latter has the values $1{\cdot}44 \times 10^{-8}$ and $1{\cdot}40 \times 10^{-8}$ cm., in the final (normal) states the values $1{\cdot}16 \times 10^{-8}$ and $1{\cdot}14 \times 10^{-8}$ cm. We have also found a difference in the vibration frequency for the two components of each doublet, which is evident from gradual changes in the frequency separation of the double bands. In the normal state it is about one part in 5000, and in the excited state somewhat larger and apparently in the opposite sense.

From the data now available it will be possible to calculate exactly the specific heat and magnetic susceptibility of gaseous nitric oxide.

Referring again to Fig. 1, we see the possibility of two other transitions, $^2P_2$ to $^2P_1$ and $^2P_1$ to $^2P_2$, which, however, are completely absent from our photographs. Their absence and the presence of the other two transitions are in agreement with the new theory of Hund (*Zs. für Physik*, vol. 36, p. 657, 1926). A complete account of our results will appear later, probably in the *Physical Review*.

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Inheritance in *Gammarus chevreuxi* Sexton.

An account was recently given of some new mutations in *Gammarus chevreuxi* Sexton (Nature, Feb. 6, 1926). A certain 'white-body' mutation did not behave in a simple Mendelian manner. In this mutant the body is devoid of the normal green and brown pigments. The mutant is recessive to the normal 'black-eyed' form, and the homozygote mutant has black eyes and white body (white-body Black). With certain exceptions to be considered later, 'White-body' is recessive to another mutant, the 'New Red' (with red eyes and normally pigmented body). But if homozygous for 'White-body,' the 'Red' fails not only to develop body-colour but also the red eye colour; a 'White' individual in both eyes and body results.

That these 'Whites' do carry 'Red' can be seen by crossing them with normals, Reds appearing in F_2.

From this it is evident that a cross between 'White' and 'New Red' should by simple Mendelian principles yield in F_1 either all Red-eyed individuals or 50 per cent. Red-eyed, 50 per cent. 'Whites,' according as the 'Red' individual was homo- or heterozygous for the body-colour factor. This does occur when a 'White' male is crossed with a 'New Red' female. But the offspring of a ‘White’ female and a ‘New Red’ male are *always white*. This is no question of sex-linkage, since both males and females homozygous for the ‘White’ mutation can be found.

The F_1 Whites are by no means all simple ‘Whites.’ Many of them belong to the class of ‘changelings’; these are ‘White’ at birth, but take on the appearance of ‘Reds’ as life proceeds. Broods consist either of all ‘changeling’ or 50 per cent. Changeling to 50 per cent. true ‘White’ according as the Red male is pure, or is heterozygous for ‘White.’ Changelings can be obtained not only from ‘White’ mothers, but also from certain matings of ‘White-body Black’ mothers, if carrying New Red.

The following conclusions have been invariably substantiated in the history of the stocks:

(1) Changeling whites occur only where ‘Reds’ would be expected.

(2) They *always* have a mother with a *white* body.

(3) They always behave genetically simply as Reds, but

(4) They are always heterozygous for ‘white-body.’ This last conclusion follows from their maternal derivation, since a ‘white-body’ individual is always homozygous for that mutation.

These facts seem impossible to fit into an ordinary Mendelian scheme, but the following considerations appear to provide a working hypothesis. Normal individuals possess a gene for ‘body colour’ which corresponds to the ‘white-body’ mutant gene. Individuals homozygous for the ‘white-body’ factor (whether ‘White’ or ‘white-body Black’) cannot lay down body pigment or red eye pigment. So long as its normal counterpart the ‘body-colour’ factor is present, the presence of the ‘Red’ factor ensures the manufacture of these pigments. We may therefore suppose the normal ‘body colour’ gene is concerned with the manufacture of some precursor from which pigment can be formed. In the ‘white-body’ mutant, failure to form the precursor consequently gives the ‘Red’ factor no precursor on which to act; a ‘White’ individual results.

‘White-body’ females (‘White’ or ‘white-body Black’) are unable to lay down any precursor in the egg-cytoplasm; its abundance in the normal egg is testified by intense pigment formation in the ovaries. When, therefore, a white-body female is crossed with a ‘New Red’ (possessing the normal ‘body-colour’ factor) the F_1 embryo is at a disadvantage. It possesses the necessary factors to change precursor into pigment, but at first the precursor itself is absent. (The amount brought in by the cytoplasm of the sperm may be neglected.) The embryo certainly possesses the ‘body-colour’ factor introduced by the sperm, but this must make a store of precursor *ab initio*, and probably this cannot be done until feeding commences. In any case it will be long before the deficit is made good, and it is thus easy to see why the embryos are ‘white’ on hatching. But as feeding and growth proceed the precursor deficit will be gradually made good; pigment can be laid down and the animal can assume its true ‘genetic’ appearance of ‘Red.’

In the converse cross, White male by Red female, the eggs have the normal amount of precursor, so that the genetically ‘Red’ embryos are at no disadvantage and can form pigment immediately in the normal manner.

Further results may be predicted from this hypothesis. A ‘Red’ female forms eggs containing the precursor. If she carries ‘white-body’ and is mated with a male containing ‘white-body,’ some embryos will not possess the ‘body-colour’ factor and cannot therefore form the precursor. But the initial presence of a limited supply might allow the embryo to form pigment for a short time, though later it would be unable to do so. Consequently we might expect retrograde ‘changelings’ genetically ‘white,’ but starting with a faint colour which does not develop or is lost as life proceeds. Cases of this have been observed.

Again, except for the possession of the black eye, the ‘white-body Black’ resembles a true ‘White,’ and its relation to ‘Normal Black’ is the same as the relation of ‘White’ to ‘Red.’ Therefore ‘white-body Black’ changelings should occur, which later develop into ‘Normal Blacks’ and behave genetically as such. These cases have also been found.

The phenomena described above are of interest because they seem to present a clear case of the relation of the cytoplasm to Mendelian factors. It should be understood that no question of cytoplasmic inheritance is involved.

The hypothesis outlined is simply a physiologically legitimate extension of the Mendelian theory. It may be illustrated by the not improbable supposition that the basis of the actual pigment of the body and the red pigment of the eye is some substance never formed by the animal itself but is of vegetable origin. In the normal egg sufficient of this basal substance (or precursor) is contained in the yolk to provide what is necessary for the body-colour and red eye-colour of the newly born animal, later supplies coming directly from the food. When the yolk of the egg contains no basal substance, the red eye colour and the body-colour are absent in the just-hatched young, though some or all of these young are genetically ‘Red.’ As they feed they obtain the necessary basal substance from their vegetable food, and by converting this into special pigments become normal red-eyed animals with full body-colour. These are the ‘Changeling whites.’ It ought to be possible to test this supposition experimentally.

E. W. SEXTON.
C. F. A. PANTIN.

Marine Biological Laboratory,
Plymouth, Dec. 21.

The Formation of Twin Metallic Crystals.

THE paper by Messrs. Carpenter and Tamura in the November number of the *Proceedings of the Royal Society*, on “The Formation of Twin Metallic Crystals,” presents a picture of the twin boundary which seems to me to be incorrect. The authors have assumed that the two halves of a twinned crystal are derived from each other by reflection in a plane which does not pass through atom-centres, but passes, in the case of face-centred cubic crystals, exactly half-way between two consecutive planes, through atom-centres, of the form $\{111\}$. This is improbable, because it requires, as its proponents themselves point out, abnormally small interatomic distances across the twinning plane, and correspondingly high local stresses, for which there is no experimental evidence. It seems much more reasonable to suppose that the two halves of the twinned crystal are reflections of each other in a $\{111\}$ plane which *does* pass through atom-centres. This picture of the boundary involves no abnormal distance between any atom and its immediate neighbours. Experimentally observable relations between twins are, of course, the same on either hypothesis.

Messrs. Carpenter and Tamura have been led, on the basis of their hypothesis, to conclude that in the diamond-like structures of silicon and germanium, twinning must involve even greater local distortions than those they have accepted as necessary in copper or nickel. If the view here advocated is the correct one, however, it appears that twins in silicon and germanium may have the relation of mirror-images in a common plane, through atom-centres, of the form {100}. This requires no abnormality in the least interatomic distances, and the twins can only be made one continuous crystal by rotation of either half through 90° about a normal to their common plane at a common atom-centre, or by a geometrically equivalent process. (In the case of twins on a {111} plane the corresponding rotation is through either 60° or 180°.)

L. W. McKEEHAN.

IN reply to the remarks of Mr. McKeehan regarding the paper which we have recently published, the point in question is whether twins of metallic crystals form a plane which passes through atom-centres. According to the hypothesis brought forward by us, the twinning of the face-centred cubic lattice takes place on the octahedral planes. Thus the two halves are arranged in a symmetrical position after a rotation of 180° about an axis normal to the octahedral plane. Obviously, in this case, the twinning plane does not pass through any atom-centres. In the face-centred cubic lattice the closest interatomic distance is $L/\sqrt{2}$. When twinned in the way mentioned above, however, the closest distance apart between atoms along the twinning plane is $L/\sqrt{3}$, where L is the lattice parameter in both cases. The change in the closest interatomic distance on twinning appears to be the cause of the local stress to which Mr. McKeehan refers, although, as he says, "there is no experimental evidence" regarding this point.

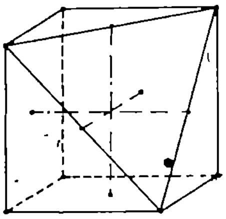

FIG. 1.

His view is apparently as follows: Two portions of two face-centred cubic lattices, both having the same geometrical form as in Fig. 1, are in contact with a plane of the octahedron passing through atom-centres so as to form the structure of mirror-images. The two portions thus share three corner atoms and three face-centred atoms in the octahedral plane. In this case, however, so far as the unit lattice form is concerned, the face-centred cube is not twinned but simply grouped in a reverse position.

With regard to the question of twinning in tetrahedral cubic crystals, Mr. McKeehan has suggested that a possible twinning plane is the cubic plane which passes through atom-centres. By a rotation of either half of the cube through 90° about an axis normal to that plane, mirror-images result, but the relations of the crystallographic axes do not change. The planes of densest atomic concentration are, however, the dodecahedral planes on which twinning does not occur. From this it would appear that the octahedral planes which possess the next densest atomic concentration are likely to be possible twinning planes. On the basis of this assumption, the closest interatomic distance of the twinned tetrahedral cubic lattice is $L/2\sqrt{3}$ instead of $\sqrt{3}L/4$, which is the closest interatomic distance of the tetrahedral cubic lattice. This is apparently the conclusion which Mr. McKeehan has considered improbable because of high local stress. It is suggested that, as in the case of the twinning of face-centred cubic crystals, if two parts of the tetrahedral cubic lattice (both having the same geometrical form) are in contact with a plane of the octahedron passing through atom-centres, the structure of mirror-images can be obtained without a change in the closest interatomic distance. These mirror-images, however, are not called twins of the tetrahedral cubic lattice. The crystallographic axis takes up a twinning position relative to the other, thereby resulting in the change of orientation. As a whole, the result is similar to that which we have assumed.

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The Scattering of Gamma Rays.

IN a letter to NATURE of December 4, Prof. J. A. Gray pointed out that a study of radiations of shorter wave-length than 0·02 Å.U. is complicated by the scattered radiations accompanying them, about which little is known. That gamma rays under certain experimental conditions appear to become less penetrating as they pass through matter was shown by Dr. Gray in 1913. Recently it has been shown by me (*Phil. Mag.*, Oct. 1926, p. 785) that the scattered radiations were considerably softer than the gamma rays producing them, and evidence was given of a comparatively soft radiation from air penetrated by gamma rays. Confirmatory experiments have since been made, a brief reference to which may not be without interest.

A given source of gamma rays was set up at different distances from an electroscope and, for each position of the source, a curve was obtained showing the apparent transmission of these rays through lead. With a lead electroscope of wall thickness 1·0 cm. the apparent transmission of lead was independent of the distance of the source from it. When the thickness of the wall was reduced to 0·17 cm. the slope of the transmission curves became less and less steep as the source was moved farther from the electroscope.

The curve, shown as Fig. 1, was obtained when a radon source equal to 127 millicuries was placed at 71 cm. from an electroscope of aluminium 0·008 cm. thick. Over the range AB of the curve the recorded ionisation is due almost solely to radiation scattered from the air around the electroscope. When the lead filters are so thick that they begin to screen this air from the direct primary rays, the ionisation decreases as shown by the curve. The transmission of the scattered radiation through aluminium was found for the experimental conditions represented by point C in Fig. 1, namely, the primary beam screened by nearly 30 cm. of lead. The scattered radiation

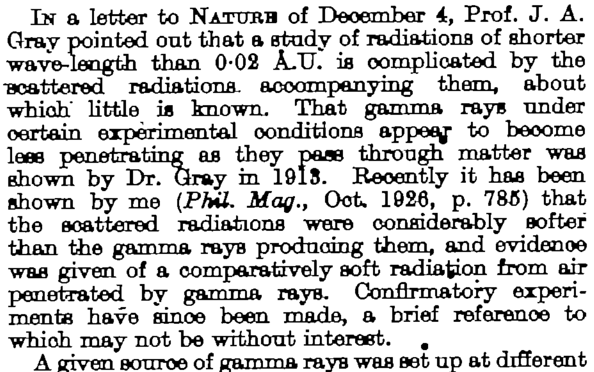

FIG. 1.

is heterogeneous, the coefficient of absorption in aluminium of the softest and hardest components being respectively 39·7 cm.$^{-1}$ and 0·051 cm.$^{-1}$. In order to determine the nature of the radiation scattered from air it is being subjected to a magnetic field, and experiments of this kind are in progress.

Some experiments to determine the effect upon ionisation measurements of lining the electroscope with different substances have also been made. A comparison of the curves, showing the transmission of radiation through lead obtained with an electroscope (*a*) unlined and (*b*) lined with cardboard 0·18 cm. thick, affords very definite information about the quality of the radiation responsible for the ionisation observed. It was found that, when the ionisation was due to radiation of the same wave-length as the primary gamma rays, the insertion of the lining increased the apparent transmission of a filter, the transmission value for a lead filter 10·1 cm. thick being 1·27 times that found with the lining removed. When the ionisation was due partly to scattered radiation, the apparent transmission of the filter was decreased by inserting the lining into the electroscope. The unlined electroscope in this case gave a transmission figure for a lead filter 6·0 cm. thick, which was 1·39 times that found when the electroscope was lined with cardboard. One has therefore a means, likely to prove useful in absorption experiments, of detecting any change in the quality of the radiation entering the electroscope, with the thickness of the filter placed in the primary beam.

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Multiple Chromosomes and Reduction Division in Flowering Plants.

IT has been the general practice to speak of the chromosomes shown in the metaphase plates in the root-tips (and other somatic tissues) of flowering plants as single chromosomes. They are never, it seems, called bivalents, dyads, or disomes; though they always show a fine longitudinal split distinctly, in correctly fixed preparations. The chromosomes of the late prophase and first metaphase of the maturation divisions in flowering plants have, in my opinion, a close parallelism to those of the somatic divisions; in that the two chromatids of any one of the two homologous chromosomes are rendered visible only through the appearance of a fine longitudinal split, seen in correctly fixed preparations.

Hence it seems we need not necessarily call such a split chromosome (in flowering plants) a bivalent, dyad, or disome. It seems more convenient to call it a single chromosome, as in the case of the somatic division, and to speak of its two halves as chromatids, not as chromosomes; and this in fact seems to be the usual practice. Similarly, at the first anaphase and second metaphase, where the two chromatids have usually separated, except at the points of constriction, we usually, it seems, call the double *V*, etc., as it proceeds to the pole, a single chromosome. When it appears again in the second metaphase plate, as a double *V*, or a four-lobed cross, we again usually call it a single split chromosome. Hence we may perhaps define a single individual chromosome as normally consisting of two halves (chromatids) which have not yet completely separated. When they have *completely* separated, we have two chromosomes.

The reverse does not hold. For when two completely separate chromosomes come together (as in the prophase of maturation) they do not form a single chromosome, but a bivalent, dyad, or disome; and show double in well-fixed preparations. (The above seems to embody the prevailing usage with regard to flowering plants.)

The reduction division, in one of the old senses of the term—namely, reduction in the number of each gene from two to one—has, with the discovery of segmental interchange (crossing-over), ceased to have a signification, as Bridges has already pointed out.

In the second meaning of the term, namely, a reduction in the number of chromosomes, it seems still available. Using the limits of the term 'chromosome' as defined above, at the first maturation division the reduction is from nuclei with n bivalents, which must of course count as $2n$ chromosomes, to nuclei containing only n chromosomes. Hence the reduction division in the diploid flowering plants yet examined is the *first* of the two maturation divisions. This is confirmed by true triploid plants, in which the reduction metaphase has n trivalents, giving $3n$ chromosomes, as defined above. There are formed, after reduction, nuclei with groups of split chromosomes, each consisting of $2n-p$, where p has the values from 0 to n. Here again there is a reduction from $3n$ to something between $2n$ and n. Also in some haploid plants at least, with n single chromosomes (each presumably consisting of two chromatids), these chromosomes proceed to either pole without distinctly splitting, and split there. In this case there is a reduction from n to $n-p$, where p has the values from 0 to n.

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Colorimetric Determination of the Oxidation of Hæmocyanin.

IN a recent paper confirming a previous finding by myself (*British Journal of Experimental Biology*, vol. 3, 1925) to the effect that the hæmocyanin of Cancer has minimum affinity for oxygen at a *p*H *circa* 7·0, Stedman and Stedman (*Biochemical Journal*, vol. 20, 1926) make the following comment on the colorimetric method:

"Although the colorimetric method might be expected to give accurate results and possesses the advantage of being rapid and simple, it is evident that curves obtained by this method under different conditions of acidity will not be comparable unless the standards are in each case maintained at the same degree of saturation. This condition will not be fulfilled in the case of hæmocyanin from Cancer and Homarus, if the standards are in equilibrium with air and the temperature is as high as 23° C. It is improbable that they were fulfilled at the slightly lower temperature of 18·7° employed by Hogben in the case of Cancer serum. . . . While the colorimetric method is undoubtedly capable of indicating the general influence of *p*H on a particular hæmocyanin, the results so obtained can have no quantitative significance unless care is taken to avoid the sources of error indicated above."

This criticism is surprising in view of the fact that the standards used, as explicitly mentioned both in published statement and in personal communication to the Stedmans, were prepared from normal serum of Cancer. It has been shown by these authors (*Biochemical Journal*, vol. 19, p. 547) that the normal serum of Cancer at room temperature is 88·1 per cent. saturated at an oxygen partial pressure of 21·7 mm., and 100 per cent. saturated at 80 mm., *i.e.* at half the partial pressure of oxygen in the atmosphere.

Moreover, their curve on p. 548, fig. 1, shows that the normal serum of Cancer is fully saturated at little over 40 mm. But if this were not so, it is not necessary to subject the serum to a pressure of 360 mm. oxygen to ascertain whether the blood is fully saturated. Since the curve for normal serum is itself determined as a preliminary procedure, such information is provided by the fact that over the greater part of the range of pressures employed, the curve is asymptotic to a line parallel with the abscissa.

I may further add that the colorimetric method employed is not, as the Stedmans state, a modification of the one proposed by Redfield and Hurd. The colorimetric method for determining the dissociation curve of hæmocyanin advocated by Mr. Pantin and myself (*Jour. Marine Biol. Ass.*, 1925) is in both essential points entirely different from that which Redfield and Hurd applied to the study of Limulus.

LANCELOT HOGBEN.

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Dec. 4.

Decomposition of Nitrogen Pentoxide.

IN a recent paper read to the Chemical Society on December 2 last, I described experiments which show that when nitrogen peroxide is illuminated by light from the mercury vapour lamp a photochemical stationary state of the nature

$$2NO_2 \underset{\text{dark}}{\overset{\text{light}}{\rightleftarrows}} 2NO + O_2$$

is set up. This change involves a slow but perfectly reversible pressure increase in the gas when illuminated. The light from the mercury vapour lamp between 4360 Å.U. and 3650 Å.U. was shown to be probably wholly photochemically active, but the experiments did not show definitely if light of longer wave-length than this contributed to the effect, since the mercury spectrum is weak between 5460 Å.U. and 4360 Å.U. In view of these results, it does not seem advisable to retain Fazel and Karrer's hypothesis of the photochemical decomposition of nitrogen pentoxide in the presence of nitrogen peroxide (*J.A.C.S.*, 28, 2837, 1926). Arguing from the apparent analogy with other photosensitised systems, these authors suggest that photoactive molecules of NO_2 activate molecules of N_2O_5 by collisions of the second kind, and bring about the decomposition of the latter.

In view of the experiments referred to above, a more probable explanation of the effect of the nitrogen peroxide would seem to be according to the following scheme:

$$(1)\ 2NO_2 \xrightarrow{\text{light}} 2NO + O_2;$$

$$(2)\ NO + N_2O_5 \longrightarrow 3NO_2.$$

In the absence of N_2O_5 the reverse of equation (1) occurs. If nitrogen pentoxide be added to the system, reaction (2) occurs in preference to the reverse of reaction (1), since it is a bimolecular change, while the latter is definitely termolecular (Bodenstein and Lindner, *Zeit. Phys. Chem.*, 100, 87, 1922). It would therefore appear that the decomposition of nitrogen pentoxide is not a true photosensitised reaction, but rather a secondary dark reaction occurring between the nitrogen pentoxide and one of the products of photochemical decomposition of nitrogen peroxide. It is obvious from this explanation that nitrogen peroxide should have no effect on the thermal decomposition of nitrogen pentoxide, in agreement with the experiments of Hirst (*J.C.S.*, 127, 657, 1925), and of White and Tolman (*J.A.C.S.*, 47, 1240, 1925).

R. G. W. NORRISH.

Department of Physical Chemistry,
University of Cambridge,
Dec. 9.

Winter Thunderstorms in the British Islands.

APPEALS were made on several occasions during last winter for reports of any thunder or lightning which might be observed during the first three months of 1926. The census of storms was carried out in conjunction with the Meteorological Office, and efforts were made to secure the co-operation of observers in all parts of the British Isles. Between two and three thousand records were sent in, showing the number of days on which thunder or lightning was reported from each country, between Jan. 1 and Mar. 31, 1926, to be as follows:

1926	England and Wales.	Scotland.	Ireland.	British Isles.
January . .	17	4	15	21
February . .	11	6	5	13
March . .	9	11	6	15
Totals (3 months)	37	21	26	49

The figure—49 days—for the British Isles is eight days less than that obtained during the same period in 1925. The number of days for Scotland and Ireland is very probably too low, on account of the small numbers of observers in those parts.

In England and Wales there were four very prominent stormy areas: one of these was in south-west Yorkshire and south Lancashire, and another was the district round the Severn Estuary. There was a belt of country free from storms in the Midland counties: a similar feature has been noticed in previous winters.

The investigation is being continued during the present season, and I shall be very grateful for reports of any thunder or lightning which may be observed by readers of NATURE before April 1 next. A note of the place, date, and time of the occurrence, with the direction in which the lightning is seen, especially at night, will be very valuable. Any additional information of the following character will be welcome:

1. The time when the storm passed overhead, or was nearest, with its direction; how long it lasted.
2. Severity of storm; much or little thunder, or lightning.
3. Whether it was accompanied by rain, hail, or snow.
4. Direction and strength of wind; change of wind (if any).
5. Whether there was a change in temperature during the storm.

S. MORRIS BOWER.

Langley Terrace,
Oakes, Huddersfield, Jan. 8.

The Infra-Red Spectrum of Hydrogen.

IN view of the considerable attention given to the secondary spectrum of hydrogen in recent investigations, it may be worth announcing that this spectrum has been extended photographically so far as 9300 Å.U. into the infra-red. Neocyanin plates were used, hypersensitised by an ammonia bath. About 170 additional lines to those recently published by Allibone (*Proc. Roy. Soc. A.*, 112, 196, 1926) were measured, about 120 of these being above his uppermost limit. Some of the more intense lines beyond the highest values hitherto published are (Int. Å.U. vac.):

9161·9
8970·3
8901·3
8878·5
8810·2
8797·6
8749·6
8726·8
8673·4
8666·6
8586·9
8577·5
8548·8
8538·1
8530·7
8522·9
8488·6
8446·6
8400·9
8369·5

Since dispersion was sacrificed for the sake of intensity in this preliminary work, these values may be in error by several tenths of an angström. The work is to be repeated under higher dispersion.

By altering conditions of the discharge to obtain a practically pure monatomic spectrum, five higher members of the Paschen series, the fourth to the eighth inclusive, were obtained photographically. Their measured wave-lengths agree with the values calculated according to the Bohr formula to within the limits of experimental error. The wave-lengths are (Int. Å.U. in air):

Line.	Observed λ.	Calculated λ.
P_δ	10049·8	10049·5
P_ϵ	9546·2	9546·0
P_ζ	9229·7	9229·1
P_η	9015·3	9014·9
P_θ	8863·4	8862·9

A. H. Poetker.

Johns Hopkins University,
Baltimore, Md.,
Nov. 24.

Lengthened Chain Compounds of Sulphur.

Dr. G. M. Bennett, in comments on a note on the above subject published in Nature (Oct. 16, 1926, p. 555), questions the purity of the compounds of the type $Br . C_2H_4(S . C_2H_4)_nBr$ obtained by the interaction of dithioethylene glycol and ethylene dibromide. From a consideration of melting-points some of the lower homologues may be regarded as 'impure,' but it should be borne in mind that the presence of minute traces of impurities would raise or depress their melting-point, but all the same, analyses of the compounds would establish definite composition. This does not, however, apply to the case of $Br . C_2H_4(S . C_2H_4)_{46}Br$. The preparation of this compound was repeated at least two dozen times under the experimental conditions detailed in the original paper, and the melting-point and analytical results agreed remarkably well. Moreover, it retained, even on crystallisation from molten naphthalene, the same melting-point and composition. These facts are sufficient to justify our claims to the purity of the compound. Further, the suggestion of Dr. Bennett that the compound might be contaminated with "substances some of which do not contain bromine," is rather doubtful in view of the fact that non-brominated substances could not be found after the disruption of the molecule by ethylene dibromide.

In conclusion, I may point out that chain compounds of sulphur having high molecular weights and definite structures are but few. Ray and Guha (*J. Chem. Soc.*, 115, 547, 1919) obtained a chain compound of (sulphonium) sulphur having so high a molecular weight as 3472.

P. C. Rây.

University College of Science
and Technology,
Calcutta.

Tuning-Forks with Parallel Prongs.

When the butt end of a vibrating tuning-fork is placed on a table, the fork will give out, under certain conditions, in addition to its fundamental, a note which is of frequency one octave higher than the note heard when the fork is held to the ear. This fact has been stated by Ellis (Helmholtz, "The Sensations of Tone" second English edition, p. 54), but apparently no explanation has been put forward.

That the effect is to be expected on theoretical grounds may be made clear by considering a fork with two parallel prongs. When the fork vibrates the prongs oscillate on either side of the mean position, and they pass through the parallel position *twice* during each complete vibration. If the fork were freely suspended the centre of mass would not move, and therefore the butt would be at its maximum displacement whenever the prongs are parallel. Consequently the octave should be present when the butt of the fork is pressed against the table. Most forks do not show this effect, as they are constructed with their prongs inclined at a small angle to each other. Therefore when they are set in vibration the prongs never reach the parallel position, and the octave is not present.

At the suggestion of Dr. L. F. Richardson an experiment was made on a tuning-fork with prongs inclined outwardly, which did not previously show the effect. The steel of the fork was softened and the prongs were put in a vice, so that they could be bent into any desired position. It was found that the octave was not present when the prongs were inclined either towards or away from each other, but occurred very markedly when they were made parallel. It was also noticed that the octave was most pronounced for large amplitudes and gradually died away as the amplitude decreased, leaving only the fundamental present.

R. S. Maxwell.

Westminster Training College,
Horseferry Road, S.W.1, Dec. 22.

Polar Pressures.

As I happen to be the author of a sentence quoted by Prof. Hobbs (Nature, Dec. 25, p. 915) from a review in the *Geographical Journal* (Sept. 1926) of his recent book on the glacial anticyclones, may I be permitted to point out that an essential word is omitted from the quotation and that Prof. Hobbs thus misrepresents what I wrote. My full statement was this: "Prof. Hobbs seems to think that the observational evidence fails to warrant the prevalent idea that there are vast circum-polar cyclonic whirls, which he is unable apparently to co-ordinate with his Antarctic glacial anticyclone. Yet in a masterly analysis Dr. Jeffreys has recently demonstrated (*Q. J. R. Met. Soc.*, vol. 52, p. 85) that whatever superficial increase of pressure there may be over either pole, or over Greenland, in consequence of the cold, this is a shallow surface effect; and that both poles are fundamentally seats of low pressure."

By the omission of the word *fundamentally* from the quotation, Prof. Hobbs deprives my sentence of the power to indicate the very co-ordination which I hold him to be incapable of effecting. The high pressures of the glacial anticyclones of Antarctica and Greenland, and of the North Polar wind-divide, are relatively slight, as Prof. Hobbs himself apparently allows, and can be reconciled with circum-polar low pressure at higher levels, for which there is a good deal of evidence apart from any theoretical considerations. The rest of the matter I leave to Dr. Jeffreys as more immediately concerned.

L. C. W. Bonacina.

27 Tanza Rd.,
Hampstead, N.W.3, Dec. 29.

A Dynamical Theory of the Electromagnetic Field.[1]

THE proposed Theory seeks for the origin of electromagnetic effects in the medium surrounding the electric or magnetic bodies, and assumes that they act on each other not immediately at a distance, but through the intervention of this medium.

The existence of the medium is assumed as probable, since the investigations of Optics have led philosophers to believe that in such a medium the propagation of light takes place.

The properties attributed to the medium in order to explain the propagation of light are—

1st. That the motion of one part communicates motion to the parts in its neighbourhood.

2nd. That this communication is not instantaneous but progressive, and depends on the elasticity of the medium as compared with its density.

The kind of motion attributed to the medium when transmitting light is that called transverse vibration.

An elastic medium capable of such motions must be also capable of a vast variety of other motions, and its elasticity may be called into play in other ways, some of which may be discoverable by their effects.

One phenomenon which seems to indicate the existence of other motions than those of light in the medium, is that discovered by Faraday, in which the plane of polarisation of a ray of light is caused to rotate by the action of magnetic force. Professor W. Thomson[2] has shown that this phenomenon cannot be explained without admitting that there is motion of the luminiferous medium in the neighbourhood of magnets and currents.

The phenomena of electromotive force seem also to indicate the elasticity or tenacity of the medium. When the state of the field is being altered by the introduction or motion of currents or magnets, every part of the field experiences a force, which, if the medium in that part of the field is a conductor, produces a current. If the medium is an electrolyte, and the electromotive force is strong enough, the components of the electrolyte are separated in spite of their chemical affinity, and carried in opposite directions. If the medium is a dielectric, all its parts are put into a state of electric polarization, a state in which the opposite sides of every such part are oppositely electrified, and this to an extent proportioned to the intensity of the electromotive force which causes the polarization. If the intensity of this polarization is increased beyond a certain limit, the electric tenacity of the medium gives way, and there is a spark or " disruptive discharge."

Thus the action of electromotive force on a dielectric produces an electric displacement within it, and in this way stores up energy which will reappear when the dielectric is relieved from this state of constraint.

A dynamical theory of the Electromagnetic Field must therefore assume that, wherever magnetic effects occur, there is matter in motion, and that, wherever electromotive force is exerted, there is a medium in a state of constraint; so that the medium must be regarded as the recipient of two kinds of energy—the actual energy of the magnetic motion, and the potential energy of the electric displacement. According to this theory we look for the explanation of electric and magnetic phenomena to the mutual actions between the medium and the electrified or magnetic bodies, and not to any direct action between those bodies themselves.

In the case of an electric current flowing in a circuit A, we know that the magnetic action at every point of the field depends on its position relative to A, and is proportional to the strength of the current. If there is another circuit B in the field, the magnetic effects due to B are simply added to those due to A, according to the well-known law of composition of forces, velocities, &c. According to our theory, the motion of every part of the medium depends partly on the strength of the current in A, and partly on that in B, and when these are given the whole is determined. The mechanical conditions therefore are those of a system of bodies connected with two driving-points A and B, in which we may determine the relation between the motions of A and B, and the forces acting on them, by purely dynamical principles. It is shown that in this case we may find two quantities, namely, the " reduced momentum " of the system referred to A and to B, each of which is a linear function of the velocities of A and B. The effect of the force on A is to increase the momentum of the system referred to A, and the effect of the force on B is to increase the momentum referred to B. The simplest mechanical example is that of a rod acted on by two forces perpendicular to its direction at A and at B. Then any change of velocity of A will produce a force at B, unless A and B are mutually centres of suspension and oscillation.

Assuming that the motion of every part of the electromagnetic field is determined by the values of the currents in A and B, it is shown—

1st. That any variation in the strength of A will produce an electromotive force in B.

2nd. That any alteration in the relative position of A and B will produce an electromotive force in B.

3rd. That if currents are maintained in A and B, there will be a mechanical force tending to alter their position relative to each other.

4th. That these electromotive and mechanical forces depend on the value of a single function M, which may be deduced from the form and relative position of A and B, and is of one dimension in space; that is to say, it is a certain number of feet or metres.

The existence of electromotive forces between the circuits A and B was first deduced from the fact of electromagnetic attraction, by Professor Helmholtz[3] and Professor W. Thomson,[4] by the principle of the Conservation of Energy. Here the electromagnetic attractions, as well as the forces of induction, are deduced from the fact that every current when established in a circuit has a certain persistency or momentum—that is, it requires the continued action of an unresisted electromotive force in order to alter its value, and that this "momentum" depends, as in various mechanical problems, on the value of other currents as well as itself. This momentum is what Faraday has called the Electrotonic State of the circuit.

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[1] Abstract of a paper by Prof. J. Clerk Maxwell communicated to the Royal Society on Oct. 27, 1864. Reprinted from the Proceedings of the Society, vol. 13, p. 531, Dec. 8, 1864.

[2] Proceedings of the Royal Society, June 1856 and June 1861.

It may be shown from these results, that at every point in the field there is a certain direction possessing the following properties:—

A conductor moved in that direction experiences no electromotive force.

A conductor carrying a current experiences a force in a direction perpendicular to this line and to itself.

A circuit of small area carrying a current tends to place itself with its plane perpendicular to this direction.

A system of lines drawn so as everywhere to coincide with the direction having these properties is a system of lines of magnetic force; and if the lines in any one part of their course are so distributed that the number of lines enclosed by any closed curve is proportional to the "electric momentum" of the field referred to that curve, then the electromagnetic phenomena may be thus stated:—

The electric momentum of any closed curve whatever is measured by the number of lines of force which pass through it.

If this number is altered, either by motion of the curve, or motion of the inducing current, or variation in its strength, an electromotive force acts round the curve and is measured by the decrease of the number of lines passing through it in unit of time.

If the curve itself carries a current, then mechanical forces act on it tending to increase the number of lines passing through it, and the work done by these forces is measured by the increase of the number of lines multiplied by the strength of the current.

A method is then given by which the coefficient of self-induction of any circuit can be determined by means of Wheatstone's electric balance.

The next part of the paper is devoted to the mathematical expression of the electromagnetic quantities referred to each point in the field, and to the establishment of the general equations of the electromagnetic field, which express the relations among these quantities.

The quantities which enter into these equations are:—Electric currents by conduction, electric displacements, and Total Currents; Magnetic forces, Electromotive forces, and Electromagnetic Momenta. Each of these quantities being a directed quantity, has three components; and besides these we have two others, the Free Electricity and the Electric Potential, making twenty quantities in all.

There are twenty equations between these quantities, namely Equations of Total Currents, of Magnetic Force, of Electric Currents, of Electromotive Force, of Electric Elasticity, and of Electric Resistance, making six sets of three equations, together with one equation of Free Electricity, and another of Electric Continuity.

These equations are founded on the facts of the induction of currents as investigated by Faraday, Felici, &c., on the action of currents on a magnet as discovered by Oersted, and on the polarization of dielectrics by electromotive force as discovered by Faraday and mathematically developed by Mossotti.

An expression is then found for the intrinsic energy of any part of the field, depending partly on its magnetic, and partly on its electric polarization.

From this the laws of the forces acting between magnetic poles and between electrified bodies are deduced, and it is shown that the state of constraint due to the polarization of the field is such as to act on the bodies according to the well-known experimental laws.

It is also shown in a note that, if we look for the explanation of the force of gravitation in the action of a surrounding medium, the constitution of the medium must be such that, when far from the presence of gross matter, it has immense intrinsic energy, part of which is removed from it wherever we find the signs of gravitating force. This result does not encourage us to look in this direction for the explanation of the force of gravity.

The relation which subsists between the electromagnetic and the electrostatic system of units is then investigated, and shown to depend upon what we have called the Electric Elasticity of the medium in which the experiments are made (*i.e.* common air). Other media, as glass, shellac, and sulphur have different powers as dielectrics; and some of them exhibit the phenomena of electric absorption and residual discharge.

It is then shown how a compound condenser of different materials may be constructed which shall exhibit these phenomena, and it is proved that the result will be the same though the different substances were so intimately intermingled that the want of uniformity could not be detected.

The general equations are then applied to the foundation of the Electromagnetic Theory of Light.

Faraday, in his "Thoughts on Ray Vibrations,"[5] has described the effect of the sudden movement of a magnetic or electric body, and the propagation of the disturbance through the field, and has stated his opinion that such a disturbance must be entirely transverse to the direction of propagation. In 1846 there were no data to calculate the mathematical laws of such propagation, or to determine the velocity.

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[3] Conservation of Force. Berlin, 1847: translated in Taylor's Scientific Memoirs, Feb. 1853, p. 114.

[4] Reports of British Association, 1848. Phil. Mag. Dec. 1851.

[5] Phil. Mag. 1846. Experimental Researches, vol. iii. p. 447.

The equations of this paper, however, show that transverse disturbances, and transverse disturbances only, will be propagated through the field, and that the number which expresses the velocity of propagation must be the same as that which expresses the number of electrostatic units of electricity in one electromagnetic unit, the standards of space and time being the same.

The first of these results agrees, as is well known, with the undulatory theory of light as deduced from optical experiments. The second may be judged of by a comparison of the electromagnetical experiments of Weber and Kohlrausch with the velocity of light as determined by astronomers in the heavenly spaces, and by M. Foucault in the air of his laboratory.

Electrostatic units in an electromagnetic unit . .	310,740,000 metres per second.
Velocity of light as found by M. Fizeau	314,858,000.
Velocity of light by M. Foucault	298,000,000.
Velocity of light deduced from aberration . . .	308,000,000.

At the outset of the paper, the dynamical theory of the electromagnetic field borrowed from the undulatory theory of light the use of its luminiferous medium. It now restores the medium, after having tested its powers of transmitting undulations, and the character of those undulations, and certifies that the vibrations are transverse, and that the velocity is that of light. With regard to normal vibrations, the electromagnetic theory does not allow of their transmission.

What, then, is light according to the electromagnetic theory? It consists of alternate and opposite rapidly recurring transverse magnetic disturbances, accompanied with electric displacements, the direction of the electric displacement being at right angles to the magnetic disturbance, and both at right angles to the direction of the ray.

The theory does not attempt to give a mechanical explanation of the nature of magnetic disturbance or of electric displacement, it only asserts the identity of these phenomena, as observed at our leisure in magnetic and electric experiments, with what occurs in the rapid vibrations of light, in a portion of time inconceivably minute.

This paper is already too long to follow out the application of the electromagnetic theory to the different phenomena already explained by the undulatory theory. It discloses a relation between the inductive capacity of a dielectric and its index of refraction. The theory of double refraction in crystals is expressed very simply in terms of the electromagnetic theory. The non-existence of normal vibrations and the ordinary refraction of rays polarized in a principal plane are shown to be capable of explanation; but the verification of the theory is difficult at present, for want of accurate data concerning the dielectric capacity of crystals in different directions.

The propagation of vibrations in a conducting medium is then considered, and it is shown that the light is absorbed at a rate depending on the conducting-power of the medium. This result is so far confirmed by the opacity of all good conductors, but the transparency of electrolytes shows that in certain cases vibrations of short period and amplitude are not absorbed as those of long period would be.

The transparency of thin leaves of gold, silver, and platinum cannot be explained without some such hypothesis.

The actual value of the maximum electromotive force which is called into play during the vibrations of strong sunlight is calculated from Pouillet's data, and found to be about 60,000,000, or about 600 Daniell's cells per metre.

The maximum magnetic force during such vibrations is ·193, or about $\frac{1}{10}$ of the horizontal magnetic force at London.

Methods are then given for applying the general equations to the calculation of the coefficient of mutual induction of two circuits, and in particular of two circles the distance of whose circumferences is small compared with the radius of either.

The coefficient of self-reduction of a coil of rectangular section is found and applied to the case of the coil used by the Committee of the British Association on Electrical Standards. The results of calculation are compared with the value deduced from a comparison of experiments in which this coefficient enters as a correction, and also with the results of direct experiments with the electric balance.

The Induction of Melanism in the Lepidoptera, and its Evolutionary Significance.

By Dr. J. W. Heslop Harrison.

In recent years no more remarkable evolutionary phenomenon has been observed than the development and progress of melanism amongst British native Lepidoptera. Species after species of moth with pale ground colour has given rise to forms so heavily pigmented that they appear in some cases to be dark grey and in others perfectly black. Further, the course of events has not ended with the mere appearance of these melanic forms; in affected species a state of equilibrium has only been attained in the areas concerned when the whole of their representatives has assumed the melanic guise. On Tyneside, for example, twenty-five years ago the species *Boarmia repandata* (the Mottled Beauty) was quite typical; now every specimen captured is black. Moreover, the advance of this progressive melanism is not stayed locally, for new species fall under its influence every year, the latest to yield being *Phigalia pedaria* (the Pale Brindled Beauty) and *Tephrosia bistortata* (the Engrailed).

Clearly, in the development of these melanic insects we are concerned with a very noteworthy phase of evolutionary activity—noteworthy because it is taking place before our eyes. But the importance of the phenomenon does not rest here; no matter what attempts are made to minimise the connexion, it cannot be denied that upon the industrialisation of the affected area depends the incidence of melanism, or, in other words, the two are related in the way of cause and effect. Thus we are dealing with a case of evolution directed by the environment, and presumably, therefore, of the Lamarckian order.

Naturally, this view has been strongly contested by the opponents of the Lamarckian position, but, let it be emphasised, not one of those so opposed has studied the subject in the field. On the other hand, field workers are unanimous in giving it vigorous support.

At first it was the practice amongst the anti-Lamarckians, in their endeavours to explain it away, to point triumphantly to the absence of melanism in continental industrial areas, and then, when in the end such localities did provide melanic species, to account for them on the basis of chance importations from England. However, the advent of melanic varieties of species like *Cymatophora or* (the Poplar Lutestring) and *Boarmia roboraria* (the Great Oak Beauty) on the Continent, prior to their appearance in Britain (an occurrence depending simply on the fact that the species in question do not approach the smoke zones in Britain as they do in Germany), rendered this position untenable, and a new line of defence was forthwith constructed. Appeal was now made to the failure of melanic forms in the manufacturing districts of the United States. Again the irresistible weight of facts broke down the defence, for the very first species to 'go black' in England, the Peppered Moth (*Amphidasys betularia*—known in America as *Lycia cognataria*), did the same at Pittsburg. Nor is this an isolated case, for in America Holarctic species like *Tephrosia crepuscularia* (the Small Engrailed), already melanic in Europe, with typically Nearctic forms like *Phigalia titea*, have succumbed to the same influence, to be followed assuredly by many others.

Hence, whether we like it or not, the dependence of melanism on industrialisation must be granted.

With the recognition of this fact, field workers and others very early indeed began to construct theories to explain it, cold, humidity, smoke, soil, and light deficiency all being invoked as inciting agents, either in the crude form of a prime cause or as cogs in a more complex mechanism. The inadequacy of such theories, even when supplemented by natural selection, has already been demonstrated by me in an early[1] paper. In their stead, in the same publication, an alternative suggestion was put forward that metallic salts ingested with the larval food of affected species might so act directly on their germplasm as to alter its potentialities. If such a belief was correct it seemed an easy matter to devise conclusive tests of its validity.

By direct analysis of the deposits on the foliage of trees in Middlesbrough Park, it was discovered that they contained relatively large quantities of salts of manganese, iron, sodium, potassium, and other metals. Furthermore, investigations as to the manganese content of hawthorn leaves near Newcastle-upon-Tyne revealed the presence of unusual percentages of that metal, with a progressive diminution as we passed westward into rural areas.

From these, and other considerations arising out of the peculiar properties of the oxides of manganese, it was determined to supply the larvæ of carefully selected species from nonmelanic regions with food (1) artificially charged with small percentages of manganese compounds, or (2) so contaminated by having been grown within the limits of a smoky manufacturing town. In addition, it was decided to supplement the manganese cultures with parallel ones in which lead salts were employed, the exact salts utilised in the two cases being manganese sulphate and lead nitrate.

Suitable species for the investigations were found in *Tephrosia bistortata*, *T. crepuscularia*, *Selenia bilunaria* (the Early Thorn), and *S. tetralunaria* (the Purple Thorn), all of which under experimental conditions gave rise to melanic individuals. Nevertheless, by far the most important and exhaustive work[2] was carried out with southern strains of *S. bilunaria* and *T. bistortata*.

In the case of *S. bilunaria*, melanics appeared both in the lead and the manganese cultures, the critical lead broods yielding three melanics and fifty-three types and the manganese brood eight melanics and twelve types; the controls from the same source provided nothing but types.

This induction of melanism had, of course, but little significance unless the melanism was inherited, and in each of these cases, to test this, since melanics of the opposite sexes failed to synchronise in emergence, melanics were paired with types.

The F_1 batches so reared in the lead series, supplied, of course, with untreated food, contained 26 insects, all quite typical; obviously, if inherited at all, the melanism was acting as a Mendelian recessive. Inbreeding the F_1 insects provided three F_2 batches containing a total of 70 types and 23 melanics—a ratio of 3·04 : 1, which approximates exceedingly closely to the expected ratio of 3 :1.

Similarly, the F_1 manganese family contained only typical insects which, inbred to secure the critical F_2 lots, gave two broods composed of 90 types and 27 melanics—a ratio of 3·3 : 1, again suggesting that melanism was inherited as a Mendelian recessive.

Various matings designed to confirm this were made, with the outcome that, totalling all the figures pertinent to the inquiry, it was found that four families bred from the pairing of homozygous type and homozygous melanic yielded 230 types and 0 melanics, three from heterozygous type × homozygous melanic giving 93 types and 77 melanics, seven from heterozygous type × heterozygous type 363 types and 105 blacks, seven from homozygous blacks mated *inter se* 316 blacks and 2 types, and finally, two families of the origin homozygous type × heterozygous type included 132 types, all of which results lead to the same conclusion.

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[1] Harrison, "Genetical Studies in the Moths of the Geometrid Genus Oporabia, with a Special Consideration of Melanism in the Lepidoptera," *Jour. Genet.*, vol. 9, 1920.

[2] Harrison and Garrett, "The Induction of Melanism in the Lepidoptera and its Subsequent Inheritance," *Proc. Roy. Soc.* B, vol. 99, 1926.

With the results, those secured in the *T. bistortata* work were in perfect agreement—a rather unexpected fact, for, in the Boarmiinae, including the allied *T. crepuscularia*, the melanism, whether induced or natural, is always a Mendelian dominant.

As stated in the concluding remarks of the Royal Society paper (Harrison and Garrett), this work left undecided the question whether it was the metal or the acid radical which played the active part. To determine this, additional work was undertaken with a Saxon strain of *Selenia bilunaria*. This strain, after five inbred generations reared on food charged with manganese chloride, has just (Dec. 19, 1926) supplied three female insects, two types and one melanic, a further induction of melanism rendering it probable that it is to the metal that we have to look for the inciting agent.

No matter what the exact meaning of these experiments, they demonstrate, without any possibility of contradiction, that the germplasm can be influenced by external agencies; therefore, if not of direct Lamarckian import, they lend weighty support to Lamarckian views, for what is in more intimate contact, chemically or otherwise, with the germplasm than the soma?

Irrespective of this, they supply, what evolutionary theories all lack, an experimental demonstration of at least one cause of variation; in fact, they go beyond this, for they actually provide the principle, new in evolution, that food not normal to any given organism may so affect its germplasm as to give rise to heritable variations. This being granted, we see at once how a change in habitat can originate new forms and finally new species.

In no group of organisms would this be more potent than in plants, and thus, instead of an appeal to the sorting out of various genotypes as urged by Turesson [3] to account for the existence of localised genotypes in various plant species, we can conceive of their origin in the stations in which they now exist. So, too, in the variation of cultivated plants influences of the same order are at work.

Nor are animals in Nature exempt from its operations; local races of animals, under the workings of this principle, find a ready explanation, and so do the various forms into which wild animals break when domesticated. In no group of animals are its workings so beautifully illustrated than in the Insecta, particularly in the phytophagous groups.

Often enough, owing to the preference of plants to grow in definite associations, different species of plants grow intermingled. What then is more likely than the accidental transference of eggs or larvæ to the wrong foodplant? Is not the difference between species chemical? If larvæ so transferred react as in the experimental work, new [4] phytophagous races or species must arise, isolated by their attachment to a special foodplant, and induced to vary from the type from which they were derived by the influence, exerted chemically, of that foodplant. Of insects so related to one another, even in our own restricted fauna, we have many; for example, the moth *Cerura bicuspis* is purely an alder feeder, whilst its congener *C. furcula* takes sallow, the Aleurodid *Tetralicia vaccinii* feeds on bilberry, and *T. ericae* on *Erica tetralix*, the gall-gnat *Loewiola centaureae* parasitises *Centaurea nigra* and its relative *L. serratulae*, *Serratula tinctoria*, and so the list could be extended to all insect groups.

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[3] Turesson, "The Plant Species in Relation to Habitat and Climate," *Hereditas*, vol. 6, 1925.

[4] As demonstrated by me in the case of the Gallmaking sawflies of the genus Pontania in a paper now in the press.

Electro-deposition of Rubber.

FROM recent announcements in the press it would appear that some considerable changes are likely to take place in the technology of rubber as the outcome of patented developments in the process of rubber electro-deposition. So promising have been the results obtained that the American rights in the various patents concerned have been transferred from their original owners, the Anode Rubber Co. of Great Britain, the B. F. Goodrich Rubber Co., and the Eastman Kodak Co., to a new company called the American Anode, Inc., for independent exploitation. The British rights, it is understood, have just been acquired by the Dunlop Rubber Co. and its associated concerns. It is perhaps too soon yet to estimate the commercial value of the whole process, for it can only be regarded as emerging from the experimental stage; but the fact that strong financial support is already forthcoming furnishes presumptive evidence of its value.

The possibility of rubber electro-deposition dates back to 1906, when Henri observed that in rubber latex, which is a colloidal suspension of rubber particles in a serum, the particles are negatively charged and migrate to the anode under the influence of a direct-electric current. The observation found early practical application in Cockerill's process, patented in 1908, for removing rubber from latex by depositing it electrically upon a moving anode; but as this process led only to the production of crude rubber—in fact it was only intended for the coagulation of rubber from latex prior to shipment—its commercial scope was limited. The importance of the recent developments in this field arises from the discovery, made independently in 1922–23 by Klein in Hungary and by Sheppard and Eberlin in the United States, that all the ingredients essential to the production of finished rubber articles, namely, the sulphur required for vulcanisation purposes, many fillers and other compounding ingredients, as well as organic dyes and vulcanisation accelerators, can be admixed in a finely divided state with rubber latex or even with an artificial dispersion of rubber, and that the whole adsorption compound produced can be electrically precipitated as a homogeneous layer on the anode which serves as a mould. It then only remains to vulcanise the deposit in the usual way, either after separation from the metallic surface or while still adhering thereto. Of course it may not be desirable to add the vulcanising agent to the bath, but to effect a cold vulcanisation after deposition. In fact, as may be gathered from the patent literature on the subject, the process is capable of many modifications.

It will be evident that the process which has been outlined eliminates many of the cumbersome mechanical methods at present associated with the rubber industry. The operating conditions can be precisely controlled, whilst by maintaining them constant the process can be made continuous or even automatic; moreover, being a cold process throughout, the original quality and structure of the starting material are retained in the product. Against these advantages must be set the fact that, since rubber is a non-conductor, it is possible to obtain only comparatively thin sheets of rubber product, though further investigation will doubtless remove this limitation. The oxygen liberated by electrolysis at the anode gives rise to a further difficulty, inasmuch as it leads to the formation of a spongy deposit; already, however, many proposals have been made for overcoming this defect, such as the use of porous moulds surrounding the anode or the addition of reducing agents to the bath. When the technique of the process has been perfected, a reduction in the cost of manufacture of sheet rubber goods and rubbered fabrics may be anticipated; not only that, but important developments may be expected in the direction of the coating of metal and other surfaces with rubber.

Obituary.

SIR JOHN SCOTT KELTIE.

SIR JOHN KELTIE seemed endowed with perpetual youth. He regulated his activities so nicely to his increasing age that, even when well advanced in his eighty-seventh year, he was able in one day to lunch at his club, attend a long committee meeting and the Council of the Royal Geographical Society, conduct a dinner of the Geographical Club, sit through a long evening meeting of the Society, seeing and hearing everything as clearly as when a boy, and, after returning home, sit up until midnight talking over the past and planning the future for a year or two ahead. He found life so full of interest and satisfaction that there seemed no reason why he should not live to celebrate the centenary of the Royal Geographical Society in 1930, and that of his own birth in 1940. He was happy in being spared the suffering of long illness and the dulling of his physical powers; he died of bronchitis on Wednesday, Jan. 12, at work almost to the last day.

Keltie was born in Dundee on Mar. 29, 1840, inheriting from his ancestors, who dwelt in Glendevon, a store of bodily health and mental fitness, but nothing more. Unaided and self-supporting, he made his way through several sessions, first at the University of St. Andrews and then at that of Edinburgh, though without taking a degree. The choice of a career seemed to lie between the dominie's desk and the preacher's pulpit, and he qualified himself for the latter in the United Presbyterian Church. But the narrow theology of the time repelled Keltie, and he used to tell how many years later he looked up the "Year-Book" of his old Church and found his name branded with the curt comment, "Lapsed into literature."

Keltie's literary work began in 1861 with Messrs. W. and R. Chambers in Edinburgh, who were then publishing the first edition of their famous "Encyclopædia," and at this period he produced many pieces of work in various fields, including a "History of the Highland Clans." He married in 1865, and soon found life in Edinburgh too narrow for his ambition. The southing instinct of his race brought him to London in 1871, when he joined the editorial staff of Messrs. Macmillan and Co., Ltd., and remained in association with that firm to the end of his life. He acted as sub-editor of NATURE from 1873 until 1885, and as editor of the "Statesman's Year-Book" from 1880 until his death, this being the last of his literary activities and that of which he was most proud. In 1873 he wrote an article on the island of Socotra and sent it at a venture to the *Times*, which accepted it, and thus began a lifelong association with that journal. It was probably this chance which turned his attention seriously to geography in time to share in all the stirring episodes of the opening up of Africa, the penetration of central Asia, and the polar expeditions of forty remarkable years. His work on NATURE similarly developed in him a wide knowledge of the literature of science and a keen though unspecialised interest in its advances.

Keltie joined the Royal Geographical Society as a fellow in 1883, and in the following year when the Society was roused, at the instance of Mr. D. W. Freshfield, to deal with educational aspects, he was appointed inspector of geographical education and commissioned to inquire into the methods of teaching in Great Britain and abroad. On this service Keltie travelled through the principal countries of Europe and brought home a very large collection of text-books, maps, and teaching appliances which he exhibited and lectured upon in London, Edinburgh, and other places. He produced a valuable report setting forth the deplorable state of geographical teaching in the British Isles as compared with France, Germany, and Italy. From this report sprung directly the revival in teaching geography which has culminated in the training and appointment of professors or readers in every British University and the institution of a geographical tripos at Cambridge. In 1894 the librarianship of the Royal Geographical Society became vacant and Keltie was appointed to the post, then a part-time occupation, which afforded great opportunities for the pursuit of private literary work. Keltie soon became the indispensable helper of the assistant secretary—the great naturalist H. W. Bates, whom he succeeded in the secretaryship in 1892. From this time onward the administrative work of the Society engrossed his attention and could well have filled the whole time of a less untiring worker than Keltie; but it only stimulated his literary and journalistic powers and, at a time when the science of publicity was still imperfectly developed, his connexion with the press did much to enhance the prestige and popularity of the Society and the fame of the great travellers and explorers with whom he was in daily contact.

Throughout his work at the Royal Geographical Society Keltie was on the side of progress, always encouraging those who were striving after more scientific methods in exploration or discussion and always interposing a moderate but unwavering opposition to reactionary tendencies. The confidence which successive presidents and councillors reposed in his judgment made him a power in the Society and in the geographical world even in his days of silent service as secretary. After he retired from the secretaryship in 1917, he was elected to the Council and latterly acted as vice-president.

Keltie was long connected with Section E of the British Association, in which he was recorder for several years and president at the Toronto meeting of 1897; afterwards he served on the Council of the Association. He bore the lion's share of the organisation of the great International Geographical Congress of London in 1895 and was one of the secretaries at the meeting. He also supported the Geographical Association from its day of small things and helped it forward to its present splendid maturity.

Although most of his work is likely to be forgotten as journalism, much of it ranks as literature and is of more than ephemeral interest, especially his "Partition of Africa"—a study of political geography in the making—and his "Applied Geography." He initiated and edited several important series of books on travel and exploration either alone or in collaboration. In 1893 he reconstructed the serial publications of the Royal Geographical Society and made its monthly *Journal* the most popular as well as the most widely circulated paper of its kind in Europe, while at the same time maintaining to the full its scientific character and the high standard of its cartography. His skill as an editor was of a high order, and he excelled in the art of inducing difficult contributors to follow the rules.

Though no explorer and little of a traveller, Keltie exerted a powerful influence on exploration in every quarter of the globe by his close personal relations with travellers of every nationality during the last quarter of the nineteenth century and the first quarter of the twentieth. He had the quick intuition of the Highlander combined with the slow caution of the Lowlander and balanced by a tact and generalship peculiarly his own. While faithful to his superiors and to his subordinates alike, he never failed in the duty of giving sound even if unpalatable advice to the former, and he always treated the latter as fellow-workers and was scrupulously just in giving them credit for good intentions as well as good work. He attained great success in organising public ceremonial functions, and his private hospitality, aided by the charm of his daughter Mrs. T. L. Gilmour, will long be remembered.

The appreciation in which Sir John Keltie's work is held by those best qualified to judge it may be estimated from the honours he received. These include gold medals from the Geographical Societies of London, Edinburgh, Paris, and New York, the honorary membership of nearly all the geographical societies in the world, the honorary degree of LL.D. from St. Andrews, the companionship of several Scandinavian orders, and finally the honour of knighthood, which he received in 1918.

Hugh Robert Mill.

Dr. C. L. Withycombe.

Dr. Cyril Luckes Withycombe, lecturer in advanced and applied entomology, died at Cambridge on December 5, aged twenty-eight years. Born at Walthamstow, the son of a schoolmaster, he early developed a peculiar taste and power for the keeping and rearing of insects, and this indicated his career. He passed his Intermediate Science Examination from Birkbeck College, and then went on to King's College, where he came under the influence of the late Prof. Dendy and of Dr. Mackinnon, on whose advice, with the object of broadening his science, he took the ordinary degree in botany, chemistry, and zoology instead of honours in one subject. He then went to the Imperial College to work under the late Prof. Lefroy, who regarded him as by far the best pupil he ever had.

During these years Withycombe spent all his spare time in the field, and he kept and reared a large series of Neuroptera, on which group he published fourteen papers, the most important being on the biology of the group in reference to the phylogenetic significance of their immature stages (*Trans. Ent. Soc.*, 1923 and 1925). The phylogeny had already been discussed by Handlirsch on palæontological evidence, and by Tillyard and Comstock on external morphology and wing venation. While their work was fully considered, the result was a modestly written discussion of the relationships of the families together, summarised by the propounding of a new phylogenetic tree, based also on the mass of new facts discovered by the author; assuredly this paper marks a stage in the scientific history of the group. It is a pity that the task he had set himself of monographing the British species cannot be carried out.

In 1923 Dr. Withycombe went to Trinidad as lecturer in entomology at the newly founded Imperial College of Tropical Agriculture. He was happy in having agreeable colleagues, and in seeing the tropics and their produce. He described to me how his first year almost daunted him with his realisation of the insufficiency of present knowledge. It was clear he was passing through his transition period, blending what he knew of three sciences into one harmonious whole. It was at this time he published his work on the bladders of Utricularia, which as a boy he had independently discovered as capturing their prey by active movement in response to stimuli. His thought henceforth was of his plant first, and this is well seen in his research on the sugar-cane froghopper blight in Trinidad. Here he was dealing with a pest not introduced but belonging to the forests of the island, only secondarily attacking the canes. Having studied his insects and his plant together as one entity, his advice to the planter is to attend with the greatest care to his cultivation, in particular to see that his canes have plenty of water physiologically available for their growth. "Canes do not necessarily show serious blight when froghoppers have been abundant, nor is an abundance of the insect a necessary condition for serious blight." Other research in Trinidad resulted in the discovery of a bollworm, *Sacadodes pyralis*, a moth, the life history of which was worked out, and much time was spent in studying and rearing successive generations of cotton stainers, Dysdercus, bugs which prefer cotton to their natural Malvaceous plants and stain and rot the cotton lint by the bacteria and fungoid spores they introduce.

Dr. Withycombe only came to Cambridge in August last, and he at once set to work on his material of froghoppers and Dysdercus. He had to prepare a course of advanced lectures, and he had a sub-department to get into order. As a lecturer he was almost conversational, as he had seen everything of which he spoke, and his class loved him. As a colleague we admired and loved him too, for he had a most lovable personality, quite extraordinary vision, and absolute devotion to research. J. S. G.

MR. CHARLES HARDING, formerly an assistant in the Meteorological Office, died at Eastbourne on Sunday, Jan. 9, in his eighty-first year. Mr. Harding entered the Meteorological Department of the Board of Trade in 1861, and was among those who transferred to the service of the Meteorological Committee when the Office was reconstructed in 1867 after the death of Admiral Fitzroy. He thus had experience of the Office under all the different forms of administration through which it had passed, with the exception of the most recent one of all under the Air Ministry. For some thirty years Mr. Harding was Principal Assistant in the Marine Division, and served under three Marine Superintendents, Captain Toynbee, Lieutenant Baillie, and Captain M. W. Campbell Hepworth. He retired in 1911, but returned during the War for part-time duty, and did not finally sever his connexion with the Office until 1920. His active career in the Office, therefore, extended over nearly sixty years. Mr. Harding became a fellow of the Royal Meteorological Society in 1874, and served on its council and as vice-president for many years. He was the author of a number of meteorological papers, dealing mainly with climatology or marine meteorology, published in the *Proceedings of the Royal Meteorological Society* and elsewhere. For some forty years he was a valued and regular contributor of notes and articles on meteorological subjects to the columns of NATURE.

WE regret to announce the following deaths:

Dr. Daniel Carhart, professor emeritus of civil engineering since 1908 at the University of Pittsburgh, on Dec. 8, aged eighty-seven years.

Dr. Forris Jewett Moore, until a year ago professor of organic chemistry at the Massachusetts Institute of Technology, on Nov. 20, aged fifty-nine years.

Sir Isambard Owen, from 1909 until 1921 Vice-Chancellor of the University of Bristol, who took a leading part in the establishment of the University of Wales (1891–93) and in the reconstruction of the University of Durham (1907–9), on Jan. 14, aged seventy-six years.

Mr. F. J. Stoakley, for some fifty years chief assistant to the professor of chemistry at Cambridge, and well known to many generations of men who have worked in the Chemical Laboratory there, on Jan. 16, aged sixty-two years.

News and Views.

IN connexion with the reprint elsewhere in this issue (p. 125) of Clerk Maxwell's own abstract of his great memoir on the electrodynamic field, our attention has been directed by Sir Joseph Larmor to the valuable group of Maxwell letters that were discovered in 1903 among Stokes's private papers. They have been made public in the "Memoir and Scientific Correspondence of Sir George Stokes," vol. 2 (1907), pp. 1-45, published by the Cambridge University Press. They are an intimate account, reporting progress in a personal way from time to time in most of his scientific activity throughout his life. These and like collections of letters, from many of the most prominent workers of the time, all preserved by Stokes, make the two volumes an almost indispensable prolegomena to the history of discovery in physical science during the latter half of last century. A very interesting account of Maxwell's early years is contained in an obituary notice written by Tait for the Royal Society of Edinburgh, and printed in NATURE, vol. 21.

PROF. G. ELLIOT SMITH has announced in the *Times* of Jan. 14 an interesting discovery which he says "should settle once for all the century-old controversy regarding the identification of certain elephant-like creatures represented . . . in Mexico, Central America, and elsewhere in the New World." Mr. J. Eric Thompson has just discovered in the Ayer Collection of the Newberry Library in Chicago unpublished water-colour sketches made more than ninety years ago by M. Frédéric de Waldeck, a French artist, of four bas-reliefs in stucco found by himself on the floor of a subterranean room in the palace at Palenque, and also a drawing of a part of the wall in the same room. The drawings on the first of the stucco slabs show two elephant's heads drawn in a floral design which is said to be suggestive of motives of the Chinese T'ang period; the second shows anthropomorphised heads "of characteristic Maya style"; the third, a conventionalised tapir; and the fourth, an egg and Haliotis shell. The design on the sculptured wall represents an elephant's head, front face with open mouth, on a serpent's body, with a conventionalised macaw and tapir heraldically grouped on each side. Prof. Elliot Smith also publishes a photograph of a crudely modelled elephant from San Salvador and two views of a painted vase discovered in 1916, at Yalloch, Guatemala, the design on which is considered by Dr. Gann, the discoverer, to represent the long-nosed god B (the feathered serpent Cuculcan, the Aztec god Quetzalcoatl), but which Prof. Elliot Smith holds to represent the elephant in the conventionalised style of Java and Eastern Asia.

As readers of Nature are aware, Prof. Elliot Smith, reasoning as a zoologist, has argued ably that certain Maya sculptures represent the Indian elephant; but is it possible in so highly conventionalised an art as that of the Maya to make any attribution at all with certainty? The varied interpretations—tortoise, tapir, macaw, and the like—which provoke Prof. Elliot Smith's amusement, are evidence of the ambiguity of the design rather than of the perversity of the attempts at interpretation. The Waldeck drawings would place the matter beyond question if they could be accepted as accurate. Prof. Elliot Smith quotes vindications of Waldeck's trustworthiness, which had been impugned; but the drawings themselves show the influence of the pseudo-classical Empire style of the French art of Waldeck's day rather than the true spirit of Maya art. It is admitted that Waldeck had a penchant for restoration. In the circumstances, it is perhaps not too much to say that a stylised reproduction of a subject already highly conventionalised needs careful verification by experts before it can be accepted as evidence beyond question.

The Gold Medal of the Royal Astronomical Society has been awarded to Prof. Frank Schlesinger, of Yale University Observatory, for his work on stellar parallax and astronomical photography. Prof. Schlesinger has done excellent observational work in spectroscopy and the variation of latitude. Specially notable is his work on stellar parallax, in which he showed how a higher standard of accuracy was attainable and took a leading part in the organisation of a number of observatories in this work. He has recently established an observatory at Johannesburg for parallax observations in the southern hemisphere. He has also initiated the use of wide angle doublet lenses for determination of position. The great accuracy which he has attained has stimulated German astronomers to re-observe the Astronomische Gesellschaft Catalogue on these lines.

At its last meeting, the Council of the Royal Photographic Society awarded the Progress Medal to George Eastman "in recognition of his inventions, researches, publications, and other work," moved partly to this step by the broad vision displayed in his founding and supporting, alike with rich endowments and active co-operation, the Eastman Research Laboratories. From this organisation, staffed by some of the most notable scientific workers that photography can claim, reports concerned with almost every aspect of the subject, from theories of light action to the commonplaces of dark-room practice, are circulated freely without other tangible reward than the gratitude of practical workers. Mr. Eastman's labours in his chosen field stretch so far back as to be barely realised by the photographer of to-day. Fifty years ago, while still a youth, he worked out from scanty data gleaned in journals of the period a method of producing dry plates (then a novelty wholly imported from Europe) and courageously started their manufacture. The same qualities led him later to devote large sums and his great practical experience to perfecting the roll-holder, and its natural sequel the daylight-loading film camera of to-day. The zest with which he interested himself in the new product celluloid, and the whole-hearted support afforded Edison in his early work in kinematography, are mainly responsible for the rapid progress made by the latter towards mechanical precision. Had Friese Greene and Le Prince, working in England, enjoyed like access to this invaluable help in their hours of difficulty, few of the film problems now puzzling British Government departments need have arisen.

The friends and admirers of the late Dr. T. S. P. Strangeways are forming a memorial fund, of which the primary object will be the provision of scholarships for his five sons. The committee includes the Master of Christ's College, the Master of Gonville and Caius College, the Master of St. John's College, the Master of Trinity Hall, the Regius professor of physic, the professor of pathology, the professor of anatomy, Sir Otto Beit, Sir Walter Morley Fletcher, Sir Charles Walston, Lady Woodhead, Dr. Cassidy, and many other well-known names. Cheques should be crossed "c.a. Strangeways Memorial Fund," and may be sent to either of the hon. treasurers: Mr. G. F. C. Gill, Lloyds Bank, Cambridge, or Prof. Sir Humphry D. Rolleston, Bart., Southfield, Trumpington Road, Cambridge; or to Dr. L. E. Shore, Dr. Louis Cobbett, or Dr. G. P. Bidder. It is obvious that a large sum will be required; and towards this £1895 has been subscribed by the Committee and a few friends.

Among the men of science of the seventeenth century—a period made memorable by the work of Gilbert, Napier, Galileo, Wallis, Hooke, and Newton—the Hon. Robert Boyle will always occupy a prominent place. Born three hundred years ago, on Jan. 25, 1627, he might be called the Cavendish of his time.

Of noble birth, Boyle was left with ample means by a father who was one of the ablest of public men. The portrait of Boyle, however, is that of a thinker and not of a man of action. He was delicate and studious as a boy and owed much to his tutor, with whom he spent some years on the continent, while in after life he was influenced by his sister, just as Pascal was by his. It was in 1654 that Boyle, then twenty-eight years of age, went into residence at Oxford, and with Wilkins and others began those meetings which led to the foundation of the Royal Society. Six folio volumes tell of his industry, and contain the results of his experiments in chemistry and physics. Following in the footsteps of Torricelli and Otto von Guericke, he improved both barometer and air-pump, and it was in his "Defence of the Doctrine touching the Spring and Weight of Air," published in 1662, that he gave us the important law known by his name. He never held any appointment, though he might have been Provost of Eton and president of the Royal Society. His death took place on Dec. 30, 1691, just a week after that of his sister. They had long lived together in Pall Mall and were buried side by side "at the upper end of the south side of the chancel" of St. Martin-in-the-Fields; but thirty years later the church was rebuilt, and to-day no one can point to his grave and no monument recalls to the stranger that Boyle was buried there.

IN the *Sunday Times* of Jan. 2, Prof. H. J. Spooner directs attention to some of the notable centenaries which occur this year. Among the names of men of science which he mentions are those of Newton, Laplace, Fresnel, Volta, and Lister. The bi-centenary of the death of Newton will be celebrated at Grantham in March, while the centenary of the death of Volta is being recognised by the holding of an electrical exhibition at Como. The custom of commemorating such events should find general acceptance, for, as Fairbairn once remarked, "the smallest honour we can do the great benefactors of mankind is occasionally to bring them to our recollection." To the names mentioned many others might be added. Next in interest to mathematicians and astronomers, after Newton and Laplace, comes that of Robert Woodhouse (1773–1827), successively Lucasian professor and Plumian professor, to whom belongs the credit of introducing the calculus at Cambridge and who found earnest disciples in Babbage, Herschel, and Peacock. Another astronomer who died the same year was Calandrelli (1749–1827), once director of the Vatican Observatory, while going back four hundred years we have the birth of Stadius (1527–1579), a predecessor of Kepler as mathematician to the Emperor of Germany. A contemporary of Stadius who should not be overlooked was the famous Dr. John Dee, alchemist and astrologer, who was born in 1527 and died in 1608.

To chemists and physicists the tercentenary of the birth of Boyle (1627–1691) and the centenary of the death of Augustin Jean Fresnel (1788–1827) will afford the greatest interest. Though Fresnel sank into an early grave he was one of the foremost students of optics, and it was only eight days before his death that Arago placed in his hands the Rumford medal of the Royal Society. Another physicist of note who died in the same year was Chladni (1756–1827), whose works on sound were translated into French through Napoleon. Henry Beaufoy (1764–1827) was both physicist and astronomer but is still better known for his experiments in naval architecture. The year 1827 saw the publication by Ohm of "The Galvanic Circuit worked out mathematically". Although no great chemist died in 1827, in that year were born Sir Frederick Abel (1827–1902), John H. Gladstone (1827–1902), Edward Nicholson (1827–1890), and, most distinguished of all, Marcellin Berthelot (1827–1907). In the same year the death occurred of Samuel Crompton (1753–1827), whose work as the inventor of the spinning mule will be the occasion of a gathering at Bolton, and also of George Medhurst (1759–1827), one of the inventors of the atmospheric railway. Among the great pioneers of last century was Sandford Fleming (born 1827), who was Engineer-in-Chief of the Canadian Pacific Railway from 1871 until 1880.

SOME considerable stir in the United States was caused in July 1925 by the trial of Mr. John T. Scopes, a science teacher of a Tennessee high school, for having taught the truth of evolution in defiance of the State law. The matter aroused widespread interest, and in our issues of July 11 and later, we published the views of a number of leading men of science and theologians on the desirability or otherwise of the control of university and school curricula by the State. It will be recalled that Mr. Scopes was found guilty, after a long trial, of breaking the State laws and was fined 100 dollars. The defence at once announced its intention to appeal against the decision of the judge and to raise the question as to whether a State law prohibiting the teaching of evolution was consistent with the constitution of the United States. The case came before the Supreme Court of Tennessee, and on Jan. 15 the verdict was given that the 'anti-evolution' law is constitutional, but that the lower court erred in fining Mr. Scopes 100 dollars. Mr. Scopes was guilty of a misdemeanour, for which the maximum penalty in Tennessee, it would appear, is 50 dollars unless the case is tried by a jury.

ON Dec. 4 of last year, the twenty-fifth anniversary of the establishment of the Bureau of Standards was celebrated at Washington. The Hon. Herbert Hoover, Secretary of Commerce, and "the only Engineer in the Cabinet," delivered the first address, in the course of which he remarked: "The Bureau to-day represents the greatest of all the world's physical laboratories. . . . I know of no laboratory, no effort of any Government that represents so liberal and so generous a support to science as is exemplified in the Bureau of Standards. To-day its appropriations approximate two and a quarter million dollars a year, a larger income than most of our universities." Referring to the Bureau and the maintenance of a high standard of living, he said, "It is only through the support of agencies of this character, and hundreds of other institutions engaged in scientific research, that we may expect with confidence that as our population grows we can still add this increment of comfort and luxury which we have enjoyed in the last century." Addresses were also given by Dr. F. A. Wolf, who referred to the time when the quarters of the Bureau consisted of two basements in the Coast Survey building on Capitol Hill; by Dr. Stratton, a former Director of the Bureau, and by Mr. Cortelyou, a former Secretary of Commerce, who spoke of the hundreds of men of high scholarship found in the Bureau, and recalled a story of Edison who, being asked by an interviewer to name the four most useful men he knew, replied, "Oh, you wouldn't recognise them. They're working around in laboratories."

The expedition to New Guinea of the Smithsonian Institution and the Scientific Research Society of the Dutch East Indies, which has penetrated 250 miles into the interior of Dutch New Guinea under the leadership of Prof. Stirling, has reached Singapore on its way back to the United States. According to a dispatch from the Singapore correspondent of the *Times* in the issue of Jan. 14, 8000 ethnographical specimens, a large botanical collection, and much information concerning the pygmy races has been obtained. It will be remembered that in the reports on the progress of this expedition which have been issued by the Smithsonian Institution from time to time, special stress has been laid on the value of the work in mapping and exploration which has been made possible by the use of the aeroplane. The mountain barrier was crossed and the entire upper reaches of the Bouffaer River, hitherto unknown, were mapped. The original intention of visiting Lake Habbema, at an estimated altitude of 12,000 ft., by flying was abandoned; but the expedition reached a height of 9000 ft. where three months were spent among the pygmies. These proved to be most hospitable and friendly, in contrast to the Papuans of the coastal area, who attacked the camps, the canoes, and the transport, when several of the natives were killed The expedition would appear to have been more fortunate than travellers in other parts of New Guinea in their relations with the pygmies, as it has usually been found difficult to establish contact with them.

An appeal for contributions to a Maya Exploration Fund has been issued by Sir Frederic Kenyon, Director of the British Museum. As a result of the excavations carried out last year on the site at Lubaantun, an invitation has been tendered to the trustees of the British Museum by the Government of British Honduras to undertake the supervision of the archæological exploration of the Colony. The trustees are prepared to accept the responsibility if funds allow; but as the resources at their disposal are limited, they ask for the financial support of the British public in this undertaking, which promises results of exceptional importance. A capital sum of £40,000 to £50,000 is required to meet an annual cost of £2000 for exploration from year to year. British Honduras, though a small territory, contains remains of every phase of Maya civilisation. As explorations of the last two or three years have shown, it is impossible to place any limit to the extent and character of the material which may be forthcoming from this area to help in elucidating the fascinating problems which bear upon the origin and development of the prehistoric culture of Central America. At Lubaantun itself, in the course of two seasons' work, features unique in Maya art and architecture have been brought to light. That the continuous and systematic archæological exploration of the country should be undertaken at the request of the Colonial Government is in itself a gratifying mark of the recognition of the importance of these priceless monuments of antiquity, which hitherto have not only been utterly neglected by the authorities, but have not even been protected from the vandalism of any chance comer.

A booklet entitled "The National Institute for Research in Dairying: Its Work and Needs," compiled by the staff, deals with the inception, development, and aims of the National Institute for Research in Dairying, which is now located (under the University of Reading) at Shinfield, near Reading. During the time that the Institute has been established—some fourteen years—it has overcome many of its initial difficulties and has tackled some of the pressing problems of dairying with vision and enthusiasm. In face of what has been accomplished, it is to be hoped that the question of finance, which still hinders the work, will receive attention. It is not only those directly connected with dairying who are indebted to the Institute, but also the general public for the benefits which arise from the Institute's campaign for clean milk. The work of the Institute is classed under the headings of (*a*) management and feeding of dairy stock, (*b*) the chemical constitution and other properties of milk and milk products, (*c*) the methods of handling and distribution of milk. In each of these sections, not only has attention been given to the practical aspect of the various questions, but also the underlying scientific problems have been thoroughly studied. This has necessitated a very large amount of chemical, physical, and bacteriological investigation.

From the beginning, the National Institute for Research in Dairying has placed the production of clean milk in the forefront of its programme, and it has succeeded in stimulating a very keen interest in this subject throughout England. At the present time there is a steady increase in the number of clean-milk competitions, which are mainly organised by the county authorities. In 1925 the number of these competitions totalled 35, and there is every reason to expect an increase in the future. Demonstrations of methods to be employed in producing clean milk on the farm are now a feature of many county and local agricultural shows, and the visits of the county dairy instructors or instructresses to the farms in their respective areas are spreading the knowledge which is so vital to success. Most of these dairy teachers have been to a special course of instruction at the National

Institute, so that, in addition to research, the Institute plays a very important part in training and stimulating those who are able to influence the farmer in this important question of clean, safe milk.

THE inaugural meeting of the Institution of Fuel Technology was held in London on Dec. 7 and 8 last. Sir Alfred Mond, in his presidential address, discussed the problem of fuel generally in an interesting and stimulating manner. He pleaded for more co-operative effort in the scientific development of fuel, and more optimism in industry as a whole. T. Hardie read a paper on modern practice in gas manufacture, based on the experience of the Gas Light and Coke Co. The thermal efficiency of carbonisation in modern vertical retorts has reached 85 per cent., and of carburetted water-gas manufacture nearly 70 per cent. Prof. R. T. Haslam, Massachusetts Institute of Technology, contributed a theoretical discussion on the combustion of carbon, and Sir Richard Redmayne a paper on the German brown coal industry, giving a very comprehensive account of the fuel itself and of the various processes to which it is now put; it emphasised the potential value of such a low-grade fuel when suitably exploited. A paper was contributed by W. E. Groume-Grjimaflo, of Petrograd, on his theory, based on hydraulic analogy, of the flow of furnace and heating gases, and its application to furnace construction. S. McEwen discussed the economies of low-temperature carbonisation, with special reference to the supply of pulverised fuel and its use. Dr. J. S. Owens gave an account of modern views on smoke and public health. The *Fuel Economist* for December contains a full account of the papers and discussions, which are of considerable interest and value.

WE learn from the report for the past year of the British Photographic Research Association, which was presented to the Council by the Director of Research on Nov. 23, that the Association has now entered on the last year of its second period of grant from the Department of Scientific and Industrial Research, and is therefore obliged to consider the question of the future. The Association is supported financially by the subscriptions of its members, supplemented by a grant from the Department, and in this manner has been enabled to make a really good start and thoroughly to justify its existence during the last nine years. We wish we could add that it was thoroughly well established, but the obviously uncertain nature of its income must be a source of anxiety to every member of the staff, and now and then leads to the loss of valued assistants, who naturally are ready to pass to appointments of a more apparently secure character.

AT the last annual general meeting of the Association, a resolution was passed that "it is of great importance to the industry that the British Photographic Research Association should be continued, and that every effort should be made to secure its continuation on a sound financial basis." We sincerely hope that these efforts will be made, and that they will be crowned with a success that will enable the Association not only to feel that it is well established but also that it may look forward to a healthy growth. The last year has added eight to the total of its scientific communications published, and two others are in the press. In addition, four summaries of literature have been circulated, frequent meetings of the staff with members of the scientific staffs of manufacturing firms have been held, and three lectures have been given in response to "requests from outside circles." Assistance or advice given confidentially to the members of the Association is one of the other activities of the research staff, but its main work is to supplement and not to replace the research departments of the various manufacturing firms, by attacking fundamental problems rather than those immediately concerned with factory work. It is pleasing to note that a certain feeling of distrust that existed at first on the part of some manufacturers has now been replaced by one of confidence in the research staff of the Association and its Director.

THE Society for Experimental Biology met at Bedford College, London, on Jan. 10 and 11. At the first session Prof. A. E. Boycott described experiments to determine the cause of the local distribution of Planorbis and Bithinia in a group of ponds, Mr. R. E. Chapman showed the effect of bicarbonates on photosynthesis in water plants, Dr. W. K. Slater discussed the effect of anaerobic conditions on the metabolism of the cockroach, and Dr J. Needham communicated a paper on the carbohydrate metabolism of the developing egg. A number of demonstrations of plant and animal experiments were also made. The second session, which was devoted to a symposium on the relative growth of parts, in which Prof. J. S. Huxley, Miss M. Shaw, and Messrs. M. Perkins, John Hammond, J. T. Cunningham, and others took part, was characterised by lively discussion. In the third session Dr. C. M. Yonge described intracellular digestion in Metazoa and Mr. G. F. Marrian explained the inter-relationships of respiratory pigments. Mr. G. P. Wells summarised experiments on the action of cations on invertebrate muscle, and Mr. V. J. Clancy described recent work on the biochemistry of scleroproteins which go to form skeletal and protective structures in animals and plants. At the annual meeting twenty-two new members were elected, and on the evening of Jan. 10 a dinner at the Florence Restaurant was attended by about fifty members and guests.

AT the fourth annual meeting of British zoologists in the rooms of the Zoological Society on Jan. 8, it was proposed by Prof. Stanley Gardiner, and carried unanimously, "That this meeting represents to the Trustees of the British Museum the desirability of equipping zoological expeditions for the purpose of obtaining as full a record as possible of the past and present fauna."

THE Research Association of British Paint, Colour and Varnish Manufacturers has made arrangements to purchase a property at Teddington near to the National Physical Laboratory, to be used as its research station and laboratories. It is hoped that the premises will be ready for occupation by the end of March. A Technical Advisory Committee has been appointed to consider and draw up the preliminary programme of research, and a second member of the technical staff has been appointed, namely, Dr. J. O. Cutter.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant master to teach engineering science in the day junior Technical and Evening Technical Schools, Truro—The Principal, Technical Schools, Truro (Jan. 28). A secretary to the Royal Asiatic Society—The Secretary, Royal Asiatic Society, 74 Grosvenor Street, W.1 (Jan. 29). A lecturer in machine drawing and design in the department of engineering, University College, Nottingham—The Registrar (Jan. 31). An assistant editor of British Chemical Abstracts—B (Applied Chemistry)—The Secretary, Bureau of Chemical Abstracts, 46 Finsbury Square, E.C.2 (Feb. 4). A principal of the Teachers' Training College and professor of education in the University of Western Australia—The Agent-General for Western Australia, Savoy House, Strand, W.C.2 (Feb. 10). A test assistant at the Royal Aircraft Establishment for general assistance to the scientific staff of the wind tunnel section of the Aerodynamic Department—The Chief Superintendent, R.A.E., South Farnborough, Hants. (Reference No. A. 142).

Our Astronomical Column.

COMETS.—Mr. Blathwayt, who discovered his first comet a year ago, has now found a second one, which is of the ninth magnitude, being the brightest comet that has been in sight for several months. The place of discovery is Braamfontein, near Johannesburg, and the position on Jan. 13 at $1^h\ 28{\cdot}0^m$ is given as R.A. $15^h\ 44^m\ 0^s$, S. Decl. 29° 46′, daily motion $+12^s$, S. 50′. The comet is too far south for observation in England, but may come northward later.

Prof. J. Comas Sola, of Fabra Observatory, Barcelona, has discovered an object of doubtful character (comet or minor planet). Its place on Jan. 10 at $0^h\ 30{\cdot}0^m$ U.T. was $8^h\ 19^m\ 20^s$, N. Decl. 2° 22′, daily motion $-1^m\ 28^s$, S. 18′, magnitude 12·4. If it is a minor planet, it must have a fairly small mean distance and a high inclination, so that it is an object of interest in any case.

Dr. A. C. D. Crommelin has deduced the following orbit of comet 1926 f. (Comas Sola) from photographic observations by G. Merton and F. J. Hargreaves on Nov. 10, Dec. 3, Dec. 24:

$$\begin{aligned} T &= 1927 \text{ Mar. } 22{\cdot}1992 \text{ U.T.} \\ &\left.\begin{aligned} \omega &= 38^\circ\ 27'\ 30''{\cdot}8 \\ \Omega &= 65\ \ 36\ \ 29{\cdot}2 \\ i &= 13\ \ 45\ \ 40{\cdot}0 \end{aligned}\right\} 1926{\cdot}0 \\ \phi &= 35\ \ \ 5\ \ 39{\cdot}5 \\ \log q &= 0{\cdot}248639 \\ \text{Period} &= 8{\cdot}51645 \text{ years.} \end{aligned}$$

These elements indicate a close approach to Jupiter in May 1912, and are therefore compatible with the suggestion of identity with Spitaler's comet 1890 VII. Very large perturbations are required to make this possible; the aphelion distance having increased from 5·08 to 6 568, which latter is 1¼ units beyond the orbit of Jupiter.

EPHEMERIS FOR 0^h.

	R.A.	N. Decl.	log Δ.
Jan. 24	$2^h\ 39^m\ 46^s$	18° 40′	0·148
Feb. 1	2 49 52	20 26	0·166
„ 9.	3 2 10	22 14	0·183

The comet should be readily observable until May, which would be six months after discovery. It remains within a few degrees of Mars for some time.

THE MINOR PLANETS.—Prof. H. N. Russell gives in the *Scientific American* for January an interesting summary of our present knowledge on this subject. Keen visual scrutiny revealed 300 planets between 1847 and 1891; then the photographic method was introduced and led to a great increase in the rate of discovery, more than 1800 discoveries having been announced between 1891 and 1926. At present, 1046 planets have been well observed and have received permanent numbers; about 1000 more are known to exist, but their orbits are only roughly determined.

The search cannot be pronounced a waste of time, if only for the fact that it led to the discovery of Eros, which gives such an excellent means of determining the solar parallax. Albert, Alinda, and Ganymede resemble Eros in travelling partly within the orbit of Mars. The group of six Trojan planets, which make equilateral triangles with Jupiter and the sun, give an example in the heavens of a solution of the 3-body problem which Laplace had announced from theory more than a century earlier. Dr. Baade's remarkable asteroid Hidalgo, the orbit of which extends from Mars to Saturn and is more eccentric than many cometary orbits, also presents interesting features, and raises some puzzling questions in cosmogony.

It is satisfactory that international co-operation in observing the minor planets, which broke down during the War, is being established afresh. Prof. M. Wolf's first photographically discovered planet was lost for some thirty years, and was then recovered in America, though it needed a long series of observations to establish the identity.

SATELLITES OF MARS.—These satellites offer some interesting problems, owing to their close proximity to Mars, with resulting shift to their orbit planes, due to the planet's oblateness. There is also the possibility of some alteration of the mean motion of Phobos as a reaction of tidal friction. Hence the series of measures made in 1924 with the 26-in. equatorial at the United States Naval Observatory, Washington, by A. Hall, E. C. Bower, and Miss E. A. Lamson (*Astr. Jour.*, No. 873) is of interest. The corrections to the mean daily motions are:

	Deimos.	Phobos.
Hall . .	−0·000060°	+0·000099°
Bower . .	−0 000107°	+0·000097°

The deduced values of the reciprocal of the mass of Mars are:

	Deimos.	Phobos.
Hall . .	3,108,500	3,157,100
Bower . .	3,127,200	3,212,100

Giving Deimos double weight, owing to the larger arc subtended by its orbit, the weighted mean is 3,140,100. Thus the observed value of the mass is nearly 2 per cent. smaller than the accepted value, rather a large difference.

Research Items.

Anthropometry of the Aborigines of South Australia.—Dr. T. D. Campbell and Dr. Aubrey J. Lewis have published in the *Transactions of the Royal Society of South Australia* for 1926 observations on 28 aborigines (11 males and 17 females) from the camp at Ooldea on the edge of the Nullarbor Plain. Most of them belong to the Alinjera group, a few to the Willoorara group. Individual measurements are given, the mean values working out as follows: Stature, 1593·4; cranial length, 187; cranial breadth, 135; nose height, 43·2; nose breadth, 44·8. The means of the indices are: Cephalic, 72·2; facial, 81·7; nasal, 104·6; ear, 53·1; radio-humeral, 81·5. The figures are compared throughout with those collected by Prof. Wood-Jones and Dr. Campbell on varying numbers of individuals, in one case—stature—more than three hundred, and are found to approximate to them fairly closely. They go to confirm the assertion that the aborigine of Central Australia belongs to a pure stock with well-defined and constant physical characters. He is dolichocephalic, platyrhinic, and dolichokerkid, the breadth of his ear is about half its length, while as to his jaw, the mean index is fairly constant though there is considerable individual variation.

Early Records of Californian Indians.—Although Bancroft, for the purpose of his "History of California," drew freely on most of the available sources, a re-examination of these, mostly diaries of Spanish priests who accompanied punitive or exploratory expeditions—records not generally available—has shown that they contain much supplementary material of archæological or ethnological value. Mr. E. W. Gifford and Mr. W. E. Schenk, who have already published material relating to the southern San Joaquin Valley in the *University of California Publications in American Archæology and Ethnology*, have now issued the data relating to the California Delta region in vol. 23, No. 2 of the same series. The records of the expeditions in question extend from the year 1772 to 1849. They throw an interesting light on the sources of food supply, comment being made on several occasions on the vast quantity of game. At Carquinez great mounds of fresh-water mussel shells were observed in the vicinity of a native village; but probably two different stages of culture were represented. Of the general conclusions which can be drawn, the most interesting is that based on evidence pointing to the infiltration of European influence. In 1819 the capture of forty-nine horses belonging to the Muquelemes near the Calaveras-San Joaquin confluence is significant, and the object of many of these expeditions was to recover escaped converts. The possible mixtures and modifications of physical types which resulted imposes great caution in the interpretation of skeletal evidence from certain groups or regions. Radical differences in cultures are difficult to note. Conclusions as to the numbers of the population require a large margin of error. In 1806 there may have been anything from 3,000 to 15,000 inhabitants. In 1870 the Indian population in this area had fallen to 5.

The Mandshurian Tiger.—The area inhabited by the tiger in the Far East is widely separated from the main area comprising India and southern China. The Mandshurian tiger, according to recent researches by Baikov, recorded in *Priroda*, Nos. 5-6, 1926, should be regarded as a species distinct from the southern tiger and more closely related to the fossil cave tiger of Europe. It differs even in its habits from the southern species, which lives in the jungle, for the Mandshurian tiger lives in *taiga*, *i.e.* in the dense forests peculiar to eastern Siberia, and it definitely dislikes heat, going up to the mountains in summer, while in winter it is perfectly comfortable even during the hardest frosts. The principal prey of the Mandshurian tiger is wild pig, but it is doing a great deal of damage to cattle, while it also often attacks men even in the day-time.

Agricultural Map of Russia.—The Russian Institute of Applied Botany, in Leningrad, has just published a very interesting agricultural map of the country compiled by Prof. I. F. Makarov. The map itself is reproduced on a fairly large scale in colours, and shows, by the 'dot' method, the relative distribution and density of crops in the country, a single dot representing 1000 hectares of crops. This method makes the map exceedingly instructive, as even a superficial glance is sufficient to show the very irregular and peculiar distribution of cultivated land in Russian territory. Very concentrated dots indicate the highly cultivated areas of the Ukraine, of the northern Caucasus, and of the Volga region, while smaller in size but nearly as dense accumulations of dots indicate the numerous oases in the vast deserts of central Asia, which are otherwise quite devoid of dots. Of particular interest to every naturalist is the northern limit of agriculture, which is also shown on the map. The line drawn on the map shows the northernmost limits of actual cultivation of cereals during the last century; it does not coincide, however, with the northern limit of possible agriculture, or with the limit of a stable agriculture forming an economic basis of the population; it lies between these two lines. The course of the line on the map begins in European Russia at lat. 62° and runs eastwards more or less parallel to the White and the Polar Seas, but near the Ural Mountains it suddenly drops to lat. 60°. Having crossed the Urals the line runs across Siberia, now ascending, now descending again. An interesting point is shown in eastern Siberia, where the line forms an enormous loop embracing the lowlands of Yakutsk with the river Lena and its tributaries. The northernmost point in Siberia touched by the line is lat. 65° N., this being in the Yakutsk province; but in the Amur region, between the same meridian, the line comes down only to lat. 48° N., and reaches the Japanese Sea at lat. 45° N. Isolated outposts of agriculture occur in Siberia far beyond the line, and even well beyond the Arctic circle. Apart from the general map, this publication contains a number of regional maps, showing the distribution of crops in various parts of Russia in detail, as well as explanatory text giving much statistical information.

An Apparatus for Catching the Micro-fauna of the Sea-bottom.—A new apparatus for this purpose is described by Dr. Th. Mortensen (*Saertryk af Vidensk. Medd. fra Dansk naturh. Foren.* Bd. 80, pp. 445-451). Recent investigations have indicated both the magnitude and importance of the micro-fauna of the bottom deposits in the sea, but it has always been difficult to obtain adequate samples of this, since it is very laborious to sift out microscopic animals from the mass of material brought up in the dredge or trawl, while the Petersen grab, though more satisfactory, gives but a small sample. Dr. Mortensen's apparatus, designed to remedy this, consists of a fine silk net attached to a rectangular iron frame the whole being prevented from sinking into the bottom deposits by a pair of thin zinc plates which are attached to the iron frame in front and to one another behind and at either side. They are bent upwards at the anterior end like the runner of a sledge and are almost as long as the net which lies between them. In use the net skims along the surface of the mud and collects an abundant sample of the micro-fauna from the surface layers. When used on a sandy bottom, an iron bar is attached a little distance in front of the mouth of the net so as to stir up the light organisms, which remain floating long enough to be caught in the pursuing net. Excellent results have been obtained in depths up to 94 metres with this net, abundant catches of nematodes, planarians, small annelids, ostracods, copepods, and many small molluscs having been secured.

Chromosome Measurements. — The accurate measurement of chromosomes is a difficult field in which little has yet been done. An extensive and laborious series of such comparative measurements has recently been made by Nesta Ferguson (*Phil. Trans. Roy. Soc.*, vol. 215 B, pp. 225-253) on the Aloinæ, a group of Liliaceous genera comprising Aloe, Gasteria, Apicra, and Haworthia. More than fifty species were compared as regards the chromosome content of their nuclei. In all these genera there are four long chromosomes and three short ones, but seven species and varieties were found to be tetraploid, having eight long and six short chromosomes. Tables of measurements and graphs of variation in chromosome length are followed by measurements of width in different stages of mitosis, and, finally, the average volume of the chromatin in the corresponding nuclei from nine different species is computed. In the genus Haworthia this volume is 40·4 μ^3 in *H. Cooperi*, 107·7 μ^3 in *H. radula*, and 208·6 μ^3 in the tetraploid *H. tessolata parva*. It is concluded that the last has arisen through a duplication of the complete chromosome set of the nucleus. Differences in the mean length of the long chromosomes from species to species are also found, which may be significant.

The Japanese Earthquake of Sept. 1, 1923.— Broadly speaking, the origin of this great earthquake covers the whole of the land and sea-basin, which have undergone conspicuous topographical changes (Nature, vol. 115, 1925, pp. 65-66), and especially the seismic focal zone that crosses the central part of Sagami Bay from north-west to south-east. From an analysis of the seismograms obtained at Tokyo and other stations (*Proc. Imp. Acad. Tokyo*, vol. 2, 1926, pp. 401-404), Prof. A. Imamura suggests that the great earthquake consisted of a group of earthquakes which originated successively at brief intervals in different parts of the focal zone. He distinguishes in particular three earthquakes, though there may have been others in the south-eastern portion of the zone—the first, not a violent earthquake, with its epicentre below the sea and about midway between Misaki and Manazura; the second, three seconds later, a very great earthquake, with its epicentre on land about 30 miles north-north-west of the other; and the third, a very sharp earthquake, about 4¼ seconds later still, with its epicentre near the coast and due north of the first epicentre.

Miocene Mollusca from Florida. — Julia Gardiner has studied and discusses "The Molluscan Fauna of the Alum Bluff group of Florida" (U.S. Geol. Survey: *Professional Paper* 142, A-D). The Alum Bluff deposits comprise three distinct faunas, which characterise three formations known in descending order as the Shoal River, the Oak Grove Sand, and the chipola. The whole series is overlain by the Choctawhatchee Marl, and is referable to the Miocene age. The author briefly sketches the history of the Alum Bluff group and gives a map of the places of its occurrence, with tables of the distribution of the fauna and local distribution of the species. The systematic descriptions (occupying some 147 pages) follow, arranged according to Dr. Dall's classification, and include many new species, while the 27 plates of fossils are a delight to look at. Each of the four parts into which, for some occult reason, the paper is divided, is furnished with an index. One index to the whole would have been much more useful and satisfactory.

Oil Surveys in Northern Alaska.—A recent bulletin of the United States Geological Survey (No. 783-E) by Messrs. P. S. Smith, J. B. Mertie, and W. T. Foran, is in the nature of a progress report of the extensive surveys being undertaken in this territory, more particularly the Naval Reserve of 35,000 square miles set aside by President Harding in 1923; the main object of this work is the location of possible oil deposits and, if successful, their development under Government administration. Oil has been definitely proved in the Reserve in the vicinity of Cape Simpson, where two distinct seepages occur, but under what conditions it originated and in what quantity it is available, are points as yet undetermined. The general interest of the report is that part of it which touches on the special problems of development which must necessarily arise when exploiting an oil-field near to or within the Arctic Circle. For example, climatic conditions make it impossible for ships to gain access to the Reserve by sea except in the period between August 1 and early September; "even during this short period they run the hazard of being caught in the ice and lost." Clearly any quantity of petroleum won from this region could not be moved by ocean-going vessels, especially as there is no harbour as yet suitable to ships of the tanker class. Alternatively, pipe-line transport from the Reserve to an ice-free harbour would probably have to be more than 1000 miles long. "Through half this distance even trails, on which all supplies and materials would have to be hauled, are lacking, and for a third of the distance there is not even timber enough to build shelters for the workmen." Similar circumstances apply to railway construction, the cost of which would be prodigious. A further serious factor in the present case is that if the oil in transit is to be used for purposes of national defence, the line of supply would have to be safeguarded; in fact, the whole region would demand protection in view of its remoteness from Government centres. Thus a very large oilfield and a commensurate production would be necessary before the cost of practical solutions to these problems could be economically justified. Save for the strategic factor, much the same reasoning applies to the development of oilfields in north-west Canada, concerning which we hear much from time to time.

Antarctic Meteorology.—The *Boletin Mensual* of the Argentine Meteorological Office, of which the issue for 1923 has now been published, contains a résumé of the observations taken at 8, 14 and 20 hours at 74 meteorological stations in the Republic, including two stations outside the Republic at South Georgia and the South Orkneys. These observatories are the only permanent ones existing in antarctic and subantarctic regions, and so have particular value. In spite of their low latitude, 60° 44′ south, the South Orkneys had only three months with a mean temperature above freezing point, and the highest mean, in February, was only 1·2° C. In midwinter the mean fell to more than 10° below freezing point. In South

Georgia conditions were more temperate, eight months having means above freezing point, and in the warmest month the mean rose to 6·1° C. Precipitation at the South Orkneys showed the low level for the year of 481 mm.; at South Georgia it was 1257 mm. These figures, which represent fairly well the average conditions, are of interest in relation to the heavy glaciation of both island groups.

Viscosity of Metals.—Parts 1 and 2 of vol. 134 of the mathematical and physical division of the *Sitzungsberichte* of the Academy of Sciences of Vienna contains a paper by Dr. F. Hettwer, of the Physics Institute of the University, on the viscosity of metals. The specimens were cylinders 0·8 cm. diameter, 10-14 cm. long, with their axes vertical. The upper end was clamped in a fixed support, the lower in a support to which a given torsional couple about a vertical axis could be applied by means of weights. The temperature was kept constant by water circulation. The twist of the cylinder produced was measured by means of a circular scale, and its small changes by means of a mirror and scale. When first the torsional couple is applied, elastic fatigue affects the twist for some time, and the observations taken during the daytime for 10-14 days afterwards are used. The values of the viscosity obtained are: for lead 4·7, tin 24, aluminium 75, and zinc 330 multiplied by 10^{14}. For alloys the laws of viscous flow appear to be more complicated than in the case of pure metals, and the viscosity higher.

The Electrical Conductivity of the Atmosphere.—The issue of the *Physikalische Zeitschrift* for Dec. 1 contains an account of the observations made on this subject during the past three years by Dr. Rose Stoppel, with the assistance of the Notgemeinschaft der deutschen Wissenschaft. The conductivity was determined by the leak from an insulated wire 150 cm. long, 0·2 cm. in diameter, which was charged every half-hour by contact for an instant with one pole of a battery of 200 volts, the other pole of which was earthed. The decrease of potential of the wire was recorded every two minutes by a Benndorf electrometer. The observations were made in a cellar in Hamburg and in a dark room in Akreyri in the north of Iceland. At each place of observation the conductivity has a daily period with a maximum between 4 and 6 in the morning local time, uninfluenced by the period of midnight sun, but much reduced at times of aurora. The variations of conductivity are not to be accounted for by changes of sunlight, of temperature, pressure, or degree of saturation of the air, and are probably due to cosmical radiation undetected up to the present time.

Methods of Testing Electric Lamps.—The very large number of incandescent electric lamps which have to be tested to stringent specifications each year by the Bureau of Standards for the American Government departments have made it necessary to invent new methods and auxiliary apparatus so as to speed up the tests and reduce the cost. An initial photometric test of the lamp in lumens per watt is first made. Fortunately the changes in life output and efficiency for changes in voltage are sufficiently consistent for lamps of a given type to permit of computation of the required voltage at which the lamp is to be run for a life test. This voltage is considerably higher than the manufacturer's nominal service rating, and hence, as the life is much shorter, a great saving in time and money is effected. All lamps are rated and tested on the basis of total light output in lumens and efficiency in lumens per watt. As the factors for deducing the mean spherical candle-power of vacuum tungsten lamps from the mean horizontal candle power are known, they are actually measured on a horizontal photometer bar. Other lamps are measured on an integrating sphere 30 inches in diameter, the test lamp occupying a fixed position within the sphere. Very large lamps are measured in an 88-inch sphere. These three photometers have special auxiliary devices by which the necessary computations are made in a semi-automatic manner at the time the observations are taken. Detailed descriptions of these devices are given in a paper, "Recent Developments in Lamp Life-Testing Equipment and Methods," published by the U.S. Bureau of Standards (No. 325). One great advantage of the methods described is that the scales employed may be easily and quickly read without eye-strain.

Magnetisation in Alloys.—The Bell Telephone System in the United States maintains a very large research organisation called the Bell Telephone Laboratories Inc. In these laboratories G. W. Elmen discovered permalloy, an iron-nickel alloy with a permeability enormously greater than that of iron in low magnetic fields. This alloy is of the greatest importance in submarine telegraphy. In the *Bell Laboratories Record* for December, L. W. McKeehan writes an interesting popular paper giving what he calls a physical background to the properties of permalloy. In the new alloy, X-ray analysis shows that there is apparently nothing peculiar about the crystals. It exhibits a uniform solid solution of iron and nickel. A great deal of study has been devoted recently to magnetic measurements of elastically deformed specimens. It appears that permalloy acts in an entirely natural manner. It is known that magnetisation of iron, nickel, and cobalt is accompanied by changes in the interatomic forces. This is shown by the minute changes in overall dimensions. If these changes take place suddenly, energy ought to be expended, and this the author identifies with magnetic hysteresis losses. Magnetic hysteresis losses are abnormally low in permalloy. When its components iron and nickel are separately magnetised, the iron expands and the nickel contracts in the direction of the magnetic axis. It is probable, therefore, that somewhere in the region of iron and nickel alloys there will be neither expansion nor contraction on magnetisation. Two Japanese experimenters have reported that the critical composition where this phenomenon occurs makes the magnetic behaviour of permalloy most strikingly abnormal. The atoms of the iron and the nickel act together in groups and there are no sudden changes in their position. Hence hysteresis loss does not take place. This theory ought to be helpful in discovering other magnetic alloys of great theoretical interest and commercial importance.

Artificial Silk.—The *Journal of the Royal Society of Arts* for Dec. 10, 1926, contains a paper on artificial silk, read before the Society on Nov. 17, by T. Brough, chief designer of Messrs. Courtalds, Ltd. Artificial silk possesses certain features which make it distinct from the natural substance, and for this reason its name is rather misleading, but the resemblance between the two fibres is seen from the description of the processes by which they are produced. Of the four processes now in use for the production of artificial silk, the viscose is the most important, about seventy-six per cent. of the world's supply being manufactured by this method. By judicious use of artificial silk, either alone, or with the assistance of other fibres such as cotton, worsted, or natural silk, a large variety of beautiful textures can be woven, and illustrations of examples of these fabrics are reproduced.

Paris Academy of Sciences.

PRIZES AND GRANTS AWARDED IN 1926.

MATHEMATICS.—The Bordin Prize has been awarded to Serge Bernstein for his "Leçons sur les propriétés extrémales et la meilleure approximation des fonctions analytiques d'une variable réelle"; the Poncelet Prize to Paul Montel for his mathematical work as a whole; the Francœur Prize to Gaston Julia for his works on the theory of functions.

Mechanics.—The Montyon Prize has been awarded to Kyrille Popoff for his book, "Les méthodes d'intégration de Poincaré et le probleme général de la balistique extérieure"; the Henri de Parville Prize to Antoine Alayrac for his work on the theory of flight; the Henri Bazin Foundation to Léo Escande and Marcel Ricaud for their researches concerning the mechanics of fluids.

Astronomy.—The Lalande Prize has been awarded to Armand Lambert for his catalogue of fundamental stars; the Damoiseau Prize to Joseph Renaux for the whole of his work; the Valz Prize to Frank Schlesinger, Director of the Yale University Observatory, for the whole of his work, particularly for his researches relating to the measurement of the parallax of stars by the trigonometric method; the Janssen Prize to Francisco Miranda da Costa Lobo for the whole of his astronomical work; the La Caille Prize to Gaston Fayet for the whole of his astronomical work.

Geography.—The Delalande-Guérineau Prize has been awarded to Jacques Hippolyte Grossard for his geodesic work in the Nile and Congo basins; the Gay Prize to Henri Michel for his studies on the improvement of tidal rivers; the Tchihatchef Prize to the late Jean Govin for his geodesic work; the Binoux Prize between François Roland for his work, "Les cartes anciennes de la Franche-Comté," and Jules Gaultier for his researches on surveying instruments.

Navigation.—The Prize of 6000 francs (in equal parts) has been divided between Émile Georges Barrillon, for his study on the waves produced by the motion of a ship, and André Apard for his work on the hygroscopic properties of the B powders; the Plumey Prize (2000 francs) has been awarded to Frédéric Marquet for his treatise on navigation.

Physics.—The La Caze Prize has been awarded to Charles Fabry for the whole of his scientific work; the Hebert Prize to Paul Bunet for his electrotechnical work; the Hughes Prize to François Croze for his work in spectroscopy; the Clément Felix Foundation to Georges Reboul for the continuation of his studies on badly conducting substances.

Chemistry.—Montyon Prize (Unhealthy Trades). A prize (2500 francs) has been awarded to Ernest Portier for his work as a whole on industrial hygiene, and an honourable mention (1500 francs) to Louis Chelle for his researches on gases used in warfare; the Jecker Prize is divided between André Wahl (6000 francs) for his work in organic chemistry and Gustave Vavon (4000 francs) for his researches on catalysis with platinum black; the La Caze Prize to André Job for his researches on the mechanism of oxidation; the Cahours Foundation between Raymond Delaby for his work on the homologues of glycerol, and Michel Samson for his work on glass; the Houzeau Prize to Louis Hackspill for his work in inorganic chemistry.

Mineralogy and Geology.—The Fontannes Prize has been awarded to Léon Moret for his "Contribution à l'étude des spongiaires siliceux du Crétacé supérieur français."

Meteorology and Physics of the Globe.—The Victor Raulin Prize has been awarded to Joseph Lacoste for his work in mineralogy and atmospherics.

Botany.—The Desmazières Prize has been awarded to Robert Kühner for his memoir entitled "Contribution à l'étude des Hyménomycètes et spécialement des Agaricacées"; the Montagne Prize divided between Georges Mangenot (1000 francs) for his memoirs on algæ, and Pierre Dombray (500 francs) for his work entitled "Contribution à l'étude des corps oléiformes des hépatiques des environs de Nancy"; the De Coincey Prize to Irénée Thériot for work on the analysis and specification of exotic mosses.

Anatomy and Zoology.—The Cuvier Prize has been awarded to Édouard Chatton for his work on the Protozoa; the Savigny Prize to Édouard Lamy for his work on molluscs; the Thore Prize to Rémy Perrier for his two volumes on entomology in his "Faune de la France."

Medicine and Surgery.—Montyon Prizes have been awarded to Maurice Blanchard and Gustave Lefrou (2500 francs) for their researches on the acute spirochætoses of French equatorial Africa, to Louis Fournier and Louis Guénot (2500 francs) for their work on the bismuthotherapy of syphilis, and to Étienne Burnet (2500 francs) for work on Mediterranean fever. Honourable mentions (1500 francs) to Jules Le Calvé for his work entitled "L'œdème, étude expérimentale et clinique," to W. B. Palgen for his essay on the biology of some bacteria, and to Alfred Weiss for his clinical and experimental researches on colectomy. Citations to Maurice Cuvigny, Leroux-Robert, Raymond Turpin, Marcel Sendrail, and Charles Dejean; the Barbier Prize to Jules Bridré and André Donatien for their work on the micro-organism of contagious agalaxy of the sheep and goat; the Bréant Prize between Yves Kermorgant (3500 francs) for his work, "Contribution à l'étude de l'étiologie des oreillons," and Charles Pérard (1500 francs) for his work on coccidioses of the rabbit; the Godard Prize to Christian Champy for his work, "Sexuality and Hormones"; an honourable mention to Jacques Benoit for his work, "Recherches anatomiques, cytologiques et histophysiologiques sur les voies excrétrices du testicule chez les mammifères"; the Mége Prize to Alberico Benedicenti for his work, "Malati, medici e farmacisti"; the Bellion Prize to Stefan Nicolau for the whole of his work; the Larrey Prize to Charles Spire and Pierre Lombardy for their work, "Précis d'organisation et de fonctionnement du service du santé pendant la guerre."

Physiology.—The Montyon Prize has been divided between Marcel Duval, for his physico-chemical and physiological researches on the internal medium of aquatic animals and the modifications produced under the influence of the external medium, and Auguste Quidor and Marcel Hérubel for their memoir on a new theory of visual perception and its applications; the La Caze Prize has been awarded to Georges Weiss for his work in biological physics; the Pourat Prize has been divided between Stefan Mutermilch (1000 francs) for his work on normal and artificial hæmolysins, and Albert Berthelot (1000 francs) for his work in bacteriology and medicine; the Martin-Damourette Prize between Henry Chabanier for his work on the rôle of the kidney in diabetes, and Maurice Chiray and Yon Pavel for their work on the contractility of the biliary vesicle; the Philipeaux Prize has been awarded to Henri Simonnet for his work on the liposoluble factor, with honourable mention to Émile Wagner for his memoir, "Le système nerveux de l'adrénalinosécrétion"; the Fanny Emden Prize to Louis Delherm and Albert Laquerrière for their work on the biological effects of various radiations.

Statistics.—The Montyon Prize has been awarded to the Institut de Statistique de l'Université de Paris for its contribution to the progress of applications of mathematics to statistics, finance, and political economy. Honourable mentions of 500 francs to Ernest Blin for his researches on the physical development of assisted children, and to Albert Ranc for his book, "Le budget du personnel des recherches scientifiques en France."

History and Philosophy of Science.—The Binoux Prize has been awarded to Henry de Varigny for his book, "La mort et la biologie."

Works of Science.—The Henri de Parville Prize has been awarded to René Legendre for his memoir on the concentration of hydrogen ions in sea water.

Medals.—The Berthelot medal has been awarded to Ernest Portier and to André Job.

General Prizes.—The Grand Prize of the mathematical sciences has been awarded to Eugène Bertrand de Fontviolant for his work on the resistance of materials; the Bordin Prize (physical sciences) to Auguste Pettit for his researches on serum for the treatment of infantile paralysis; the Lallemand Prize to Yvonne Sorrel-Dejerine for her work entitled "Contribution à l'étude des paraplégies pottiques," and a very honourable mention to Pierre Hillemand for his work, "Contribution à l'étude des syndromes de la région thalamique"; the Serres Prize to Charles Pérez for the whole of his work in embryology; the Vaillant Prize to Mme. Lucie Randoin for her researches on the physiology of nutrition, with special reference to vitamins; the Jean Reynaud Prize to Mme. Alfred Giard, in memory of the biological work of the late Alfred Giard; the De Joest Prize to Alain Quemper de Lanascol for his work on the geometry of compasses; the Houllevigue Prize to Jean Rey for his work on the physical properties of petrol vapours and their laws of flow; the Saintour Prize to Pierre Fauvel for the whole of his work on annelids; the Jules Mahyer Prize to Louis de Broglie for his studies on the quantum theory; the Lonchampt Prize to Charles Dhéré for his work on electrodialysis and the purification of proteids; the Wilde Prize (in equal parts) between Armand Renier for his studies of the Belgian coal measures, and Bruneau de Laborie for his African explorations; the Caméré Prize to René Feret for his researches on cement; the Jérome Ponti Prize to Maurice Fréchet for his work on the theory of functions; the Gustave Roux Prize to Pierre Chevey for his work in zoology; the Thorlet Prize to Adolphe Richard; the Albert I. of Monaco Prize to Jean Charcot to permit him to complete the equipment of his vessel the *Pourquoi pas?*

Special Foundations.—The Lannelongue Foundation has been divided between Mmes. Cusco and Rück.

Prizes at the Grandes Écoles.—The Laplace Prize has been awarded to Georges Parisot; the L. E. Rivot Prize to Georges Parisot, Jacques Hémar, Louis Armand, and Louis Dherse.

Foundations for Scientific Researches.—The Trémont Foundation has been awarded to Edmond Marcotte for his work on internal combustion motors; the Gegner Foundation to René Baire for the whole of his mathematical work; the Hirn Foundation to Joseph Thoret for his researches on air currents; the Becquerel Foundation to Georges Bruhat for his work in optics and physical chemistry; the Bouchard Foundation to Maxime Ménard for his work on X-rays and radiations used in therapeutics; the Le Chatelier Foundation to Jean Cournot and Albert Roux for their studies on alloys by means of the X-rays.

The Geographical Association.

THE Geographical Association held its annual meetings on Jan. 6-8 at the London School of Economics. The address of the president, Sir Charles Close, on "Population and Migration," gave a statistical investigation of world population with special reference to the development of the British Dominions. The tendency of population growth, indicated by graphs of census returns, gives some foundation for a forecast of the future. Within three-quarters of a century from 1875, England will probably pass from the period of highest birth-rate—36 per 1000—to a stationary condition in which birth-rate and death-rate will balance. Any migration policy must take this tendency into consideration, as well as the absorption rate in the Dominions, estimated at 5 per 1000. This at present would give about 100,000 per annum, excluding the quota to the United States. It is a corollary of this population movement that the dissemination of geographical knowledge of the regions of the world must occupy an increasingly important position in education.

Maps constitute one of the most important groups of geographical documents. Even the significance of the 'Bactrian Triangle' of Bukhāra, Merv, and Samarkand, discussed by Dr. Eileen Power in relation to trans-Asian caravan routes, cannot be fully realised apart from a cartographical representation of the three great east-west highways in their physico-geographical setting. But the mapping of such regions prior to the coming of the aeroplane has been financially almost impossible. Air surveys open a new era. Already such regions as the lower course and delta of the Irrawaddy, and the coastlands of British Guiana, have thus been mapped. Some 100,000 square miles of Canada have been surveyed from the air. Even vegetation distribution, in certain circumstances, can be determined, the Katanga district in particular offering interesting possibilities. In the air survey about to be undertaken there, Major Hemming thinks that the geologists will be able to locate copper ore deposits by the soil effect on vegetation, the distribution of which will be revealed by the air photographs.

Other possibilities of aircraft are under observation, as in the revision of the O.S. 1/2500, commonly called the 25-inch map, for south-east England. The Director-General of the Ordnance Survey, in discussing the official maps at present available to the public, indicated certain developments in the 1/1,000,000 map of England and Wales. Additional contours, a revision of the towns and certain other details, will enhance its value for general use, whilst the success of the map showing Roman roads encourages the Ordnance Survey to proceed with similar maps of an archæological and historical character. A special map has been prepared showing the track in Britain of the total solar eclipse which takes place on June 29 next, a phenomenon not to be repeated here until the year 1999. In this connexion Prof. H. H. Turner described, by means of photographs of previous eclipses and by ingenious mechanical slides, the formation and nature of an eclipse.

A visit to East Kent included an excursion to the Betteshanger Colliery and the housing schemes at Elvington and Aylesham. The latter, serving the needs of the Snowdown and Adisham Collieries, may be taken as the best expression of an attempt to save the beauty of the Kentish countryside in face of a possible industrial development. In the valley below Aylesham Wood, Nature offers a site for a town of ten thousand inhabitants which gives the planner of towns, both in the form and the setting of the valley, his maximum opportunity. The collieries, though less than a mile away, are effectively hidden by rising ground, the summit of which, crowned by woods and spinneys, forms an effective horizon. This Aylesham scheme is a striking application of geographical science to the economic and social needs of our times. It is one in which the unconscious and empirical adjustment due to slow growth and lack of policy—illustrated by Mrs. Ormsby's regional survey of London—may be replaced by a sound but not too rigid plan of organised urban development.

The Proposed New Biological Station in Bermuda.

WE have recently received from Prof. Herbert W. Rand, of Harvard University, a statement setting forth the history of the Bermuda Biological Station and the steps which are being taken for its reorganisation with the view of placing it on a permanent foundation and of extending its usefulness.

The station was inaugurated in 1903 through the joint activities of Profs. C. L. Bristol (New York) and E. L. Mark (Harvard), and since that time about 250 workers have carried out investigations at the station, and 141 published papers have been issued.

In August 1925 a group of American biologists interested in the Bermuda Station met to consider its future, and proposed a scheme for its complete reorganisation on the same general lines as those which have proved so successful in the case of Wood's Hole. The first step was to communicate with biologists who had either worked in Bermuda or for other reasons might be expected to be interested in the work of the station, and replies from about 150 were received, and these biologists form the corporation. They were asked to nominate a committee of reorganisation, which met in New York in Nov. 1925. Recognising the importance of securing the co-operation and support of the Bermudians, this committee sent letters to the Governor of Bermuda, to former members of the Bermuda Natural History Society, and to several other residents of the island. The responses are stated to be most encouraging. The committee arranged for the election, by ballot of the members of the corporation, of a board of twelve trustees, and it was provided that four of these should be non-residents of the United States. These are Dr. E. J. Allen, Plymouth; Prof. J. H. Ashworth, Edinburgh; Dr. A. G. Huntsman, Director of the Atlantic Experimental Station for Fisheries, Halifax, Canada; and Dr. E. A. McCallan, Director of Agriculture, Bermuda. The American trustees are Prof. E. G. Conklin, Dr. E. V. Cowdry, Dr. C. B. Davenport, Profs. B. M. Duggar, R. A. Harper, R. G. Harrison, E. L. Mark, and H. W. Rand.

Papers of incorporation under the laws of the State of New York have been prepared and approved, so that the station is authorised to accept and hold funds to establish and maintain a station for scientific study in biology. A committee is investigating the possible sites for the new station and is drawing up the detailed plans for the station and its equipment.

It is hoped that the government of Bermuda may be willing to make some provision for the station, possibly in connexion with the new aquarium now in course of construction. The Royal Society of London has intimated its interest in the scheme to widen the scope and value of a station offering such exceptional advantages of position, which, though situated in British territory, has hitherto owed its existence and development to American enterprise, and the National Research Council at Washington has passed a vote approving the project.

We understand that, when the organisation is completed, there is every hope that funds to a substantial amount will be forthcoming from America to put the station upon a sound financial basis and to make it a first-class laboratory with thoroughly adequate equipment. British marine biologists will, we are sure, follow with sympathetic interest the efforts of the committee to this end. The advantages of the Bermudas for biological research are considerable; the semi-tropical fauna can be studied under reasonable conditions of living and of climate throughout the year, and the station will be readily accessible, being reached in about forty-eight hours from New York. A well-equipped station in the Bermudas will afford the opportunity for the proper investigation of the semi-tropical waters of the Atlantic, and in these studies it is hoped British and American scientific men will be associated. We cordially wish the committee success in its endeavours to provide the means for the furtherance of this important work in marine biology.

University and Educational Intelligence.

CAMBRIDGE.—A. R. Clapham, Downing College, has been appointed to the Frank Smart University studentship in botany.

DR. GEORGE McOWAN, lecturer in chemistry in the United College of St. Salvator and St. Leonard, University of St. Andrews, has been appointed reader in chemistry at Raffles College, Singapore.

A REPORT on Higher Degrees has been issued by the Association of University Teachers as a supplement to the *University Bulletin*, vol. 6, No. 1. It represents the results of the labours of a committee of the Association appointed to inquire into the conditions under which higher degrees are awarded in the universities of Great Britain. Several years ago a similar inquiry was undertaken by the Universities Bureau of the British Empire, and summaries of the conditions have since been published in the "Universities Year-book." The committee of the A.U.T., however, has not rested content with recording existing conditions, but has fitted its record into a convenient tabular form, and has gone so far as to formulate general principles and even to suggest standard regulations which it commends to the careful consideration of the universities on the ground that, if some common agreement could be achieved, it would be to the great advantage of university study and research. The general principles recommended are: that the D.Litt. and D.Sc. should imply conspicuous ability and originality and distinguished and sustained achievement; the Ph.D., ability to study a problem systematically and to relate results to the general body of knowledge of the subject, and a definite contribution to knowledge or scholarship; and the degree of Master, the mastery of the technique of investigation. The suggested regulations include a *viva voce* examination for the Ph.D. and for the Master's degree. Standardisation is not a word to conjure with in university circles, but this report seems to deserve the consideration it asks for.

Calendar of Discovery and Invention.

January 23, 1710.—Johann Friedrich Böttger, the German alchemist, was born in 1682 and died in 1719. Apprenticed to a chemist of Berlin named Zorn, he experimented with zest with the view of the transmutation of metals into gold. From Berlin he went to Dresden, and it was while under the patronage of the Elector of Saxony that he accidentally discovered the process of making porcelain from the reddish clay found in the neighbourhood of Meissen, and on Jan. 23, 1710, the first European porcelain factory was opened at that place.

January 24, 1838.—During the voyage from Europe to America in the sailing vessel *Sully* in 1832, the American painter, Morse, then forty-one years of age, conceived the idea of signalling by electricity, using a code of dots and dashes. Six years later, on Jan. 24, 1838, he exhibited his electric telegraph in New York city, the *Journal of Commerce* stating: "Intelligence was instantly transmitted through a circuit of ten miles, and legibly written on a cylinder at the extremity of the circuit."

January 25, 1868.—Bishop Thirlwall, writing on Jan. 25, 1868, said: "I had a treat last night, which I would not have missed for any prize. Tyndall delivered the second (the first unhappily on the Friday before) of the lectures at the Royal Institution, 'On Faraday as a Discoverer.' . . . Tyndall said many fine things, not flowers of rhetoric, but springing out of the depths of their long intimate friendship. . . . He prized the honour of being Faraday's successor less than the happiness of having been his friend. The one was a mantle almost too heavy to bear, the other a memory full of the purest delight. He closed with the words, 'Let me die the death of the noble, and let my last end be like his,' and then rushed out of the room amidst a storm of applause. The attendance was just the largest that the room, with the addition of extra chairs, would hold. It was curious to see how, after it was over, people gave vent to their feelings by shaking hands, as if to congratulate one another on being present on such an occasion. It was indeed something to remember to the end of one's life. Faraday was a noble man, with heart, mind, and soul equally and healthily developed."

January 27, 1774.—One of the principal factors in engineering progress has been the development of machine tools. Among these the oldest is the lathe. A notable advance in workshop practice was made when John Wilkinson, on Jan. 27, 1774, patented his machine for boring guns in which the gun was rotated and the boring tool advanced down the bore. Called upon to make the cylinders for the engines of Watt, Wilkinson devised a machine in which the cylinder was fixed but the boring bar was supported at both ends while the cutter-head was moved along the bar, thus enabling the surface traced out by the tool to be reproduced in the work.

January 28, 1807.—Murdock in England and Le Bon in France were the pioneers of gas lighting, but its introduction for street lighting was due to the eccentric German, Winsor, through whose efforts Pall Mall was lighted by gas on Jan. 28, 1807. This was the first public thoroughfare in the world to be so illuminated.

January 29, 1886.—It was the invention of the light, high-speed spirit engine by Daimler which made the motor-car possible, but the first to apply such engines to carriages was Karl Benz. Benz's first motor-car, built in 1885, is in the Deutsches Museum, Munich; his patent is dated Jan. 29, 1886.

E. C. S.

Societies and Academies.

LONDON.

Royal Society, Jan. 13.—**F. W. R. Brambell, A. S. Parkes,** and **Una Fielding:** Changes in the ovary of the mouse following exposure to X-rays. Part i. Irradiation at 3 weeks old. Degeneration occurred of all oocytes in the ovaries of 47 female mice, exposed to full sterility dose of X-rays at 3 weeks old. Membrana granulosa and theca interna, in those cases where differentiated, degenerate also. Finally old follicles are only represented by small cavities containing zona pellucida remnants. Simultaneously with these changes, old inter-follicular tissue atrophies, and germinal epithelium proliferates epithelial cords. In adult animals ovaries are composed almost entirely of this first proliferation. In many cases a second proliferation follows. This consists of small spherical or slightly elongated cords. These cords resemble so-called spermatic cords described in ovaries of inbred rabbits and of free-martin cattle. They also resemble structures described as anovular follicles. They have no effect on oestrous cycle.

F. W. R. Brambell, A. S. Parkes, and **Una Fielding:** Changes in the ovary of the mouse following exposure to X-rays. Part ii. Irradiation at or before birth. Investigation of the ovaries of 6 mice X-rayed *in utero* and of 30 X-rayed at birth confirm the foregoing results. Of animals irradiated at birth, 24 were allowed to become adult. Cords of first proliferation constituted the bulk of all the ovaries. The cells of first proliferation appear to be responsible for production of oestrin and regulation of oestrous cycle. Production of oestrin stops at certain stage of differentiation into luteal-like cells.

A. S. Parkes: On the occurrence of the oestrous cycle after X-ray sterilisation. Part ii. Irradiation at and before birth. Further evidence is brought forward in support of conclusion that all normal cyclic oestrous phenomena except ovulation can occur in animals in which Graafian follicles of ovary have been totally destroyed at an early age by exposure to X-rays, and can occur, therefore, in the absence of organised corpora lutea and Graafian follicles.

R. M. Sargent: Recovery from vigorous exercise of short duration. Recovery from vigorous exercise of short duration is extremely rapid, especially in the first 10 minutes immediately after cessation of exercise. Rate of recovery varies somewhat with the subject and the severity and duration of exercise. It is inadvisable, in determining total recovery-oxygen after exercise, to measure the amount used during the period of incomplete recovery and apply a correction. As a result of exercise, oxygen consumption at rest was found to be increased, on average about 7 per cent. This change appears to result from genuine alteration in level of metabolism, and cannot be regarded as an integral part of recovery process as such.

R. G. Canti and **M. Donaldson:** The effect of radium on mitosis *in vitro*. It is possible to bring about cessation of mitosis in tissue cultures *in vitro* by means of radium irradiation. With the intensity of radium irradiation employed, mitosis ceases, but when the radium is removed after several hours' exposure, mitosis reappears. At commencement of irradiation, cells not only complete division when mitosis has already commenced, but some cells also actually begin mitosis and go through the process of division in apparently normal fashion. In no experiment was there any evidence of radium producing increase in the number of cells in mitosis.

R. J. Ludford and **W. Cramer:** Secretion and the Golgi apparatus of Islets of Langerhans. Appearances in the cells of the Islets of Langerhans in normal animals indicate that the cells in the same animals are at different stages of functional activity. The condition in which the most definite and uniform change has been observed is during pregnancy, in which the Islet cells are particularly active. Similar but less uniform and definite change is found after exposure of heat.

M. Dixon: On the mechanism of oxidation-reduction potential. The phenomena of oxidation-reduction potential can be predicted from the work of Wieland, and a theory in accordance with Wieland's theory of oxidation is developed and extended in various directions. An explanation of the anomalous behaviour of the sulphydryl system is suggested.

Royal Meteorological Society, Dec. 15.—**N. K. Johnson**: Some meteorological observations made at sea. Readings were taken over a period of 24 hours on a ship steaming eastwards in the Mediterranean Sea. The observations were made on May 12-13, 1926, and the sky was practically clear throughout. Air temperature showed a diurnal variation of 1°·9 F. There are also indications of a small diurnal variation in the sea temperature. The vertical temperature gradient between heights of 5 m. and 22 m. was found to possess the dry adiabatic value throughout the day but exceeded this value during the night. This result, which is exactly the reverse of what occurs on land, probably represents the normal occurrence at sea.—**N. K. Johnson** and **E. L. Davies**: Some measurements of temperature near the surface in various kinds of soil. Measurements were made throughout 1925 of the maximum and minimum temperatures recorded at a depth of about 1 cm. below the surface of six kinds of 'soil'. In summer the maximum soil temperatures are considerably in excess of the maximum air temperatures recorded in a Stevenson screen. This excess is 37° F. in the case of tarmac, and 14° F. in the case of grass-covered soil. In mid-winter the soil maxima are all practically equal to the screen maximum. The minimum temperatures recorded in the 'soils' agree closely throughout the year with the minimum air temperature in the screen. The only exception is in the case of the grass-covered soil, in which the minimum averages about 5° F. higher than the air minimum. Using a value for soil conductivity, the temperature observations were extrapolated up to the actual surface of the soil. In this way it is found that the average summer maximum for the surface of tarmac is about 115° F., and for earth and sand about 100° F. The extreme maxima for these 'soils' are calculated as about 140° F. and 130° F. respectively. In the tropics an extreme maximum surface temperature for ordinary soils may be estimated as about 180° F.—**A. N. Puri**: Investigation on the behaviour of hair hygrometers. A study has been made of four types of hair hygrometers in which the total load on the hairs consists of a weight. These were taken through a series of humidity changes controlled by sulphuric acid–water mixtures. When the hair is loaded with a weight of two grams or more, it undergoes a slow extension which extends over a period of several weeks. Hair under a smaller load gives readings which can be reproduced to measure humidity within 2 per cent. Alterations in the length of the hair due to changes in humidity show a hysteresis effect which is apparently in the reverse direction to that observed when measurements are taken in terms of change in weight.

DUBLIN.

Royal Irish Academy, Dec. 13.—**A. Farrington**: The topographical features of the granite-schist junction in the Leinster chain. The zone of metamorphic rock which surrounds the Leinster granite is more resistant to weathering than the granite and tends to form high ground at the margin of the latter. This is particularly well shown in the basin of the Slaney river, where an undulating plain of granite is shut in on three sides by high hills of schist. The valleys of the streams which flow out of the granite area are constricted where they cross the schist belt, and as a result of this narrowing the glacially eroded glens of the eastern slope of the Leinster chain are much overdeepened in the schist, a well-marked step being formed near the granite-schist junction.

Royal Dublin Society, Dec. 21.—**J. Reilly** and **Joan Sullivan**: Studies on peat (Part ii.). Distillation under reduced pressure of certain constituents of peat.—**J. Reilly** and **C. Boyle**: The production of essential oils from fresh-grown plants (Part ii.). The cultivation of *Mentha piperita* and further experiments on the winning of lavender oil.—**J. Reilly** and **J. Taylor**: (Part iii.). Oil of peppermint.—**J. Reilly** and **P. J. Drumm**: (Part iv.). Note on oil of camomile.—**W. R. Fearon**: Colour reactions associated with liver oils. Two classes of colour reactions are frequent in liver oils: (1) those obtained directly on the addition of a powerful condensing agent, such as sulphuric acid, arsenic trichloride, or phosphorus pentoxide; and (2) those obtained indirectly on the addition of an aromatic phenol before treatment with the condensing agent. Reactions of the first class appear to be intimately associated with the growth vitamin A. Reactions of the second class are independent of the vitamin, and are due to a saponifiable component of the oil.

EDINBURGH.

Royal Physical Society, Dec. 20.—**D. Guthrie**: Tattooing and its significance.—**D. J. Jackson**: The life-history of a braconid parasite of Sitona.—**A. C. Chaudhuri**: The erythrocyte count in sexually normal and abnormal fowls. The count is higher in males than in females, and is lower in castrated individuals than in normal. It is exceptionally low in hens with an extra ovary, while in cases of sex reversal it approaches that of the male.

MANCHESTER.

Literary and Philosophical Society, Nov. 30.—**Kenneth M. Smith**: Observations on some insect carriers of potato virus disease. The so-called 'virus diseases' of the potato are becoming a serious menace to the potato-growing industry of the world. The causal organism, if such there be, of this group of disorders has not yet been isolated. The diseases, however, particularly in their 'leaf-curl' and 'mosaic' forms, are known to be infectious, and in Nature are transmitted by certain insects. A number of insects which attack the potato plant have been tested under controlled conditions as to their disease-carrying abilities. The insect is first itself contaminated with the disease, and later is placed upon a potato plant under an insect-proof cage. This plant is produced by one half of a known healthy tuber, the other half tuber being grown under a separate insect-proof cage as a control. So far as results of the experiments up to 1925 go, they indicate that the aphis or certain species of aphis are the most efficient carriers of the mosaic disease of the potato. Successful inoculation was also achieved with other species of insects, in two cases with a leaf-hopper and also with the greenhouse white-fly (Aleurodes). The capsid bugs have so far failed to transmit mosaic disease.

PARIS.

Academy of Sciences, Dec. 6.—**H. Andoyer**: The method of Delaunay.—**F. E. Fournier**: General laws, unpublished, of the formation of the vertical undulatory profile of the satellite wave of a ship in motion, calm sea.—**J. Costantin**: New experimental results on the culture of *Pleurotus Eryngii*.— — **Piquier**: The general integration of the partial differential equation $s=f(x, y, z, q)$.—**Bertrand Gambier**: The deformation of surfaces and the Gauss-Codazzi equations.—**Paul Montel**: The domains corresponding to values of analytical functions.—**G. Vranceanu**: The absolute differential calculus for non-holonome varieties.—**J. Delsarte**: The study of certain integral equations which generalise those of Fredholm.—**H. Mineur**: The absolute differential calculus.—**E. M. Antoniadi**: Changes observed on the planet Jupiter. Details of further results obtained in 1926 at Meudon with the 83 cm. telescope. Illustrations of the appearances on Nov. 27, 1923, and July 1, 1913, are given. The conclusion is drawn that while in certain cases the sun may have an effect, the phenomena presented by Jupiter are for the most part inherent in the planet itself and are due to its high temperature.—**P. Helbronner**: Results of the direct geodesic junction of Corsica to the French continent.—**Jean Chazy**: The formula of the Doppler-Fizeau effect in the universe of de Sitter.—**Jean Rey**: The industrial utilisation of the energy of a warm liquid in a steam turbine. An account of an actual application in 1904 of the recent suggestion of G. Claude (*C.R.* 1926, p. 924).—**V. Posejpal**: The resonance absorption and yield of fluorescence in the domain of the X-rays.—**Edgar Pierre Tawil**: The variations of the optical properties of piezo-electric quartz submitted to high-frequency currents.—**Albert Pérard**: Study of the monochromatic cadmium radiations in Michelson and Hamy lamps from the point of view of their metrological applications.—**Paul Mondain-Monval**: The heats of mixing of partially miscible pairs (of liquids). The system methyl alcohol–cyclohexane. The heat absorbed per gram of mixture is shown graphically as a function of the percentage of cyclohexane. Curves for the temperatures 18°, 29°, 40°, and 52° C. are given, the latter being above the critical miscibility temperature.—**René Delaplace** and **Neda Marinesco**: Some physico-chemical properties of cæsium eosinate. Data are given for the number of dipoles of solvent fixed on the molecule, *p*H of aqueous solution, electrical conductivity, and molecular weight.—**Eugène Pérot**: The cementation of mild steel by cyanogen and by cyanamide. Curves are given showing the influence of temperature, time, and pressure (of the cyanogen).—**Georges Darzens**: A method of preparation of α substituted valerolactones. Alkylalkylacetic acids, a general method for the preparation of which is given, on heating to 90° C. with double their weight of 90 per cent. sulphuric acid, are converted into the α alkylvalerolactones.—**M. Tiffeneau** and **Mlle. J. Lévy**: The reality of the semipinacolic transposition: the comparative stability of the secondary and tertiary hydroxyl groups. The work of Daniloff on the transposition of trisubstituted aldehydes into ketones by the action of concentrated sulphuric acid throws some doubt on the reality of the semipinacolic transposition. Experiments on the dehydration of phenyldibenzl-, anisyldibenzyl-, and phenylethyl methyl-glycols, however, prove that there are real cases of semipinacolic transposition.—**R. Fosse**: The presence of allantoic acid in *Phaseolus vulgaris*. The presence of allantoic acid and the absence of uroxanic acid in this plant has been proved.—**L. Longchambon**: The constitution of chalcedonies and quartzines.—**René Souèges**: The embryogeny of the Papaveraceæ. The last stages of the development of the embryo in *Papaver Rhoeas*.—**A. Demolon** and **E. Natier**: The action of potassium chloride upon non-calcareous soils.—**M. Doyon** and **I. Vial**: The remarkable activity and nuclear origin of an anti-coagulating substance extracted from the mesenteric ganglia.—**Raymond Hamet**: The antagonism of atropine and adrenaline.—**P. Portier** and **Mlle. de Rorthays**. Researches on the load supported by the wings of Lepidoptera of different families.—**Maurice Azema**: The formation of the renal vesicles and the development of the kidney in *Ascidia mentula*.—**Edouard Chatton** and **André Lwoff**: The Synophrya, infusoria internally parasitic in crabs. Their evolution and place in the Fœttingeriidæ.—**J. Wolff** and **J. Loiseleur**: The biochemical oxidation of ferrous malate.—**Gabriel Bertrand**: Observations on the nature of ferrase and of certain oxydase systems with reference to the preceding paper.—**A. Philibert** and **J. Risler**: The action of neon light on bacteria.—**E. Brumpt**: The transmission of *Treponema crociduræ* by two species of Ornithodorus (*O. moubata* and *O. Marocanus*).

CALCUTTA.

Asiatic Society of Bengal, Dec. 6.—**T. V. Ramakrishna Aiyer**: Notes on some Indian Lepidoptera with abnormal habits. Examples of moths or butterflies living in association with other insects seem comparatively rare. Some examples, mainly from South India, are: Butterflies—*Spalgius epius*, West; moths—various species of the noctuid genus Eublemma; family Epipyropidæ.—**D. N. Majumdar**: (1) The bigonial breadth of some Hos of Kolhan; (2) Death and connected ceremonies of the Hos of Kolhan and Singbhum.—**Rev. H. Hosten, S.J.**: (1) Fr. N. Pimenta's Annual Letter, Goa, Dec. 21, 1599. The history of contemporary events drawn from the early missionary reports. (2) Fr. N. Pimenta, S.J., on Mogor, Goa, 1st Dec. 1600. (3) Fr. N. Pimenta's Annual of Margaõ, Dec. 1, 1601. (4) Three letters of Fr. Joseph de Castro, S.J., and the last year of Jahāngir, Aug. 24, 1626–Aug. 15, 1627. (5) Eulogy of Father Jerome Xavier, S.J., a missionary in Mogor, 1549–1617. (6) Some letters of Fr. Jerome Xavier, S.J., to his family, 1593–1612. (7) Some notes on Bro. Bento de Goes, S.J., 1583–1607.—**Mohini Mohan Chatterji**: (1) Brahmanism in Bengal. Gauda or Bengal from remote antiquity to modern times has contributed a distinct religious note, that of the combination of loyalty to Brahmanism with tolerance and universalism. (2) A study of some Bengali customs: (i) Survivals of group-marriage; (ii) Mock-marriage.

VIENNA.

Academy of Science, Nov. 25.—**R. Weiss** and **P. Fastmann**: Benzalaryl-phthalane and -naphthalane and the transformation of the former into di-substituted indone.—**E. Späth** and **A. Burger**: Opium alkaloids (vii.). Synthesis of laudanin and laudanidin.—**R. Seka, O. Schmidt**, and **K. Sekora**: Condensation products of pyro-mellithic acid anhydride.

WASHINGTON.

National Academy of Sciences (*Proc.*, vol. 12, No. 11, Nov.).—**Leonard B. Loeb**: Gas ion mobilities in ether-hydrogen mixtures. Measurements were made over the whole range of mixtures, 0–100 per cent. ether. At concentrations greater than 30 per cent. of ether the mobilities of both the positive and the negative ions follow the theoretical law of mixtures; with smaller concentrations the mobilities of the positive ions are abnormal, possibly suggesting the formation of labile clusters of ions.—**Roy. J. Kennedy**:

A refinement of the Michelson-Morley experiment (*v.* NATURE, Jan. 8, p. 64).—Paul S. Epstein: (1) On the evaluation of certain integrals important in the theory of quanta. A convenient expression is obtained for the integral which determines the matrix of the hydrogen atom, considering only the simple closed Kepler motion and neglecting relativity effect and spin of the electron. (2) The new quantum theory and the Zeeman effect.—R. M. Langer: The dispersion of atomic hydrogen. (1) A measure. A powerful discharge was passed through one tube of a pair constituting an interferometer containing hydrogen through which 'white-light' fringes were being observed. The shift of fringes at a given wave-length, together with the concentration of atomic hydrogen and index of refraction of molecular hydrogen, enables the dispersion of atomic hydrogen to be calculated. At about $\lambda = 6000$ Å.U., $\mu = 1{\cdot}000068$. The method involves certain assumptions, but is regarded as giving results of the right order. (2) A calculation. Attempts to adjust earlier dispersion formulæ to give the proper frequencies for anomalous dispersion lead to values of the index of refraction different from that obtained above.—H. B. Goodrich: The development of Mendelian characters in *Aplocheilus latipes*. There are four homozygous types of this Japanese freshwater fish: wild, yellow, white, and variegated. The colours are produced by three kinds of pigment cell, melanophores and brown and yellow chromatophores, which appear to be present in similar numbers in all four types and at the earliest stages of growth. The Mendelian gene appears to function by controlling the amount of melanin elaborated in cells which are always present.

Official Publications Received.

BRITISH AND COLONIAL.

Indian Problem and its Solution: a Letter by the Head of the Ahmadiyya Community to His Excellency the Viceroy and Governor-General of India. Pp. 31. (London: The London Mosque, Southfields, S.W.18.)

Transactions of the Buteshire Natural History Society (1926). Pp. 60+48 plates. (Glasgow and London: The Mann Publishing Co., Ltd.)

Aeronautical Research Committee: Reports and Memoranda. No. 1032 (M. 39): Some further Experiments on the Behaviour of Single Crystals of Aluminium under Reversed Torsional Stresses. By H. J. Gough, S. J. Wright and Dr. D. Hanson. Work performed for the Engineering Research Board of the Department of Scientific and Industrial Research. (B.1.a. Metals, 47.—T. 2166.) Pp. 13+8 plates. 1s. 3d. net. No. 1033 (Ae. 226): On the Advantages of an Open Jet Type of Wind Tunnel for Airscrew Tests. By H. Glauert and C. N. H. Lock. Pp. 10+3 plates. 9d. net. (London: H.M. Stationery Office.)

Address on 'The Dangers of Contraception,' delivered by Frederick J. McCann at the Caxton Hall, London, on October 29th, 1926. Pp. 16. (London: League of National Life.) 6d.

The Marine Biological Station at Port Erin (Isle of Man): being the Fortieth Annual Report of the former Liverpool Marine Biology Committee, now the Oceanography Department of the University of Liverpool. Drawn up by Prof. Jas. Johnstone. Pp. 39. (Liverpool: University Press of Liverpool, Ltd.; London: Hodder and Stoughton, Ltd.) 1s. 6d. net.

The British Mycological Society. Transactions, Vol. 11, Parts 3 and 4, December. Edited by Carleton Rea and J. Ramsbottom. Pp. 169-311. (London: Cambridge University Press.) 15s. net.

New Zealand. Department of Lands and Survey: Scenery-Preservation. Report for the Year ended 31st March 1926, together with Statement of Accounts and Schedule of Lands Acquired and Reserved during the Year under the Scenery Preservation Act. Pp. 8. (Wellington, N.Z.: W. A. G. Skinner, 1926.) 6d.

Western Australia: Geological Survey. Bulletin No. 88: Palæontological Contributions to the Geology of Western Australia. Series 7, Nos. 13, 14 and 15. By Rev. W. Bretnall, F. Chapman and Ludwig Glauert. Pp. 72 (4 plates). Bulletin No. 91: The Auriferous Lodes of the Gibraltar District, Coolgardie Coalfield By F. R. Feldtmann. Pp. 29+7 plates. (Perth: Fred. Wm. Simpson.)

Memoirs of the Department of Agriculture in India. Entomological Series, Vol. 9, No. 6: Studies on Indian Thysanoptera. By H. H. Karny. Pp. 187-220+plates 16-23. 1.8 rupees, 2s. 6d. Entomological Series, Nos. 7, 8, 9. No. 7: New Species of Indian Gall Midges (Itonididæ), by Dr. E. P. Felt; No. 8: New Indian Geometridæ, by Lewis B. Prout; No. 9: Description of *Laspeyresia sirpicola*, n.sp. (Lepidoptera), by E. Meyrick; with a Short Note on the Life-History and Status, by Rai Bahadur C. S. Misra. Pp. 241-260+plate 24. 5 annas; 6d. (Calcutta: Government of India Central Publication Branch.)

Proceedings of the Royal Society of Edinburgh, Session 1925-1926. Vol. 46, Part 3, No. 28: Researches into the Characteristic Numbers of the Mathieu Equation (Second Paper). By Dr. E. L. Ince. Pp. 316-322. 9d. Vol. 46, Part 4, No. 29: On the Cardinal Function of Interpolation-Theory. By W. L. Ferrar. Pp. 323-333. 1s. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

Proceedings of the Thirteenth Indian Science Congress (Bombay, 1926). Pp. xxiii+406. (Calcutta: Asiatic Society of Bengal.)

Records of the Botanical Survey of India. Vol. 9, No. 5: Mosses collected in Gilgit, etc., by J. Garrett and W. Lillie. By H. N. Dixon. Pp. 303-312+1 plate. (Calcutta: Government of India Central Publication Branch.) 8 annas; 10d.

FOREIGN.

Proceedings of the United States National Museum. Vol. 69, Art. 12: New Land and Fresh-Water Mollusks from Central and South America. By William B. Marshall. (No. 2638.) Pp. 12+3 plates. (Washington, D.C.: Government Printing Office.)

Instituto Geográfico y Catastral. Anuario del Observatorio Astronómico de Madrid para 1927. Pp. 528. (Madrid.)

The Rockefeller Foundation. Annual Report, 1925. Pp. xi+521 (43 plates). (New York City.)

Department of Commerce: Bureau of Standards. Technologic Papers of the Bureau of Standards, No. 325: Recent Developments in Lamp Life-Testing Equipment and Methods. By J. F. Skogland and E. P. Teele, Jr. Pp. 681-702+5 plates. (Washington, D.C.: Government Printing Office.) 15 cents.

Smithsonian Institution: United States National Museum. Bulletin 100, Vol. 6, Part 2: Contributions to the Biology of the Philippine Archipelago and Adjacent Regions. Additions to the Polychætous Annelids collected by the United States Fisheries Steamer *Albatross*, 1907-1910, including one New Genus and three New Species. By A. L. Treadwell. Pp. 181-196. (Washington, D.C.: Government Printing Office.)

Proceedings of the United States National Museum. Vol. 69, Art. 8: Crustaceans of the Orders Euphausiacea and Mysidacea from the Western Atlantic. By Walter M. Tattersall. (No. 2634.) Pp. 35+2 plates. Vol. 69, Art. 23: Cymbidium, a New Genus of Silurian Pentameroid Brachiopods from Alaska. By Edwin Kirk. (No. 2649.) Pp. 5+1 plate. (Washington, D.C.: Government Printing Office.)

New York Academy of Sciences. Scientific Survey of Porto Rico and the Virgin Islands. Vol. 4, Part 1: Geology of the Virgin Islands, Culebra and Vieques. Introduction and Review of the Literature, by James F. Kemp; Physiography, by Howard A. Meyerhoff. Pp. 141. (New York City.)

Appendix No. 2 to the Annual Report of the Chief of the Bureau of Navigation, 1926: Annual Report of the Naval Observatory for the Fiscal Year 1926. Pp. 19. (Washington, D.C.: Government Printing Office.)

Journal of the Faculty of Science, Imperial University of Tokyo. Section 2: Geology, Mineralogy, Geography, Seismology. Vol. 2, Part 1: The Tanna Earthquake of 1925. By Dr. Bundjirô Kotô. Pp. v+75+8 plates. (Tokyo.) 2.50 yen.

CATALOGUES.

The Book: its Authors, Printers, Illustrators and Binders; also a Selection of Memoirs and Autograph Letters of Literary Personalities. (No. 490.) Pp. 60. (London: Francis Edwards.)

Classified List of Second-hand Scientific Instruments. (No. 89.) Pp. vi+58. (London: C. Baker.)

Heat Treatment Bulletin No. 37: Theory and Practice in the Hardening Shop. Pp. 5. (London: Automatic and Electric Furnaces, Ltd.)

Diary of Societies.

SATURDAY, JANUARY 22.

BRITISH MYCOLOGICAL SOCIETY (in Botanical Department, University College), at 11 A.M.—W. Buddin and Miss E. M. Wakefield: Studies on *Rhizoctonia Crocorum* and *Helicobasidium purpureum*.—E. W. Mason: On the Naming of a Dark Spored Hyphomycete.—J. Ramsbottom: Fragmenta Mycologica V.—Miss K. Sampson: Anthracnose Diseases of Red Clover.—R. C. Woodward: Studies on Apple Mildew.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. E. W. Tristram: English Medieval Wall-Painting.

PHYSIOLOGICAL SOCIETY (at National Institute for Medical Research, Hampstead), at 2.30.—Demonstrations by Prof. L. Hill: Measurement of Capillary Pressure in the 3rd day Chick-Embryo.—J. A. Campbell: Chamber for Continuous Exposure to High and Low Percentage of Oxygen.—T. Angus: Apparatus for Studying the Arc-lamp as a Source of Ultra-violet Radiations.—H. W. Dudley: Apparatus for Working up Tissue-extracts on an Intermediate Scale.—Dr. H. H. Dale and A. N. Richards: Continuous Record of Oxygen Absorption by Small Animals.—W. Feldberg: Histamine Vasodilatation in the Rabbit.—R. Bodo and H. P. Marks: Aseptic Perfusion of Isolated Heart.—Papers by Prof. H. S. Raper: Indole Derivatives from Tyrosine.—Dr. G. V. Anrep and R. Kinosita: The Influence of Mechanical Factors of the Circulation upon the Diastolic Volume of the Ventricles.—Prof. R. J. S. McDowall: The Relation of Alkali to the Parasympathetic (Preliminary Communication).—M. A. Battie and Prof. R. J. S. McDowall: The Effect of Alkali on the Blood Sugar.—K. Furusawa and P. M. T. Kerridge: The Buffering Power of the Uterus of the Cat.—J. A. Campbell: Effects of Exposure to Low Tensions of Air and Oxygen.—C. H. Best, Dr H. H. Dale, H. W. Dudley, and W. V. Thorpe: Histamine, the Vasodilator Principle of Extracts from the Lung.—Dr. H. H. Dale and A. N. Richards: The Vasodilator Action of Small Doses of Adrenaline.—Prof. L. Hill: The Biologically Active Rays of Sunlight.—Dr. G. A. Clark: The Immediate Effect of Vagus Section on Blood-Sugar Level.—E. M. Boock, J. H. Burn, and

J. W. Trevan: The Accuracy of the Assay of Strophanthus and Squill by Different Methods.—J. H. Burn and J. M. Ellis: The Amount of Specific Alkaloid in Different Samples of Ergot, assayed by Clark's Method.

Hull Association of Engineers (at Hull Municipal Technical College), at 7.15.—G. F. O'Riordan: A Two Years' Retrospect.

MONDAY, January 24.

Royal Irish Academy, at 4.15.

Royal Society of Edinburgh, at 4.30.—A. R. Normand, J. D. Ross, and E. Henderson: The Distribution of Intensity in the X-Ray Spectra of the Normal Saturated Dicarboxylic Acids, their Diethyl, and Mono-Ethyl Esters.—W. J. McCallien: The Geology of Gigha.—Prof. H. Briggs: Rock-Faulting from the Engineering Standpoint.

Institution of Automobile Engineers (Loughborough Graduates' Meeting) (at Loughborough College), at 7.—Mr. Short: Carburettors.

Institution of Electrical Engineers (Informal Meeting), at 7.—M. Whitgift and others: Debate on The Electricity Bill.

Institution of Electrical Engineers (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.—J. Firth and F. Buckingham: The Electrical Equipment of Large Buildings.

Institution of Electrical Engineers (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—Col. E. Mercier: Notes on the 60,000-Volt Underground Network of the Union d'Electricité.—P. Dunsheath: 33,000-Volt Cables with Metal-Sheathed Cores, with special reference to the S.L. Type.

Institution of Mechanical Engineers (Graduates' Section, London), at 7.—Major A. R. Valon: Mechanical Engineering in the Army in Relation to the Duties of an Ordnance Mechanical Engineer (Lecture).

Aristotelian Society (at University of London Club), at 8.—H. H. Price: Mill's Theory of the External World.

Royal Society of Arts, at 8.—Dr. L. C. Martin: Recent Progress in Optics (Cantor Lectures) (1).

British Medical Association, at 8.—Sir Berkeley Moynihan: Cancer and how to fight it (Hastings Lecture).

Royal Society of Medicine (Odontology Section), at 8.—Dr. J. H. Maclean: The Bacteriology of Dental Caries.—Prof. H. P. Pickerill: Non-eruption of Teeth.

Medical Society of London, at 8.30.—Pathological Evening.

Royal Geographical Society (at Æolian Hall), at 8.30.—J. M. Wordie: The Cambridge Expedition to East Greenland.

Institute of Chemistry (Leeds Area Local Section).—Prof. J. W. Cobb: The Training of a Fuel Chemist.

TUESDAY, January 25.

Royal Society of Arts (Dominion and Colonial Meeting), at 4.30.—B. H. Morgan: The Sugar Resources of the British Empire.

Royal Society of Medicine (Medicine, Surgery, and Laryngology Sections), at 5.—Dr. L. S. T. Burrell, Dr. F. Chandler, Dr. G. Marshall, and Dr. K. D. Wilkinson (*Medicine*), T. Edwards, J. E. H. Roberts, and H. S. Souttar (*Surgery*), G. E. Martin, C. A. S. Ridout, and V. E. Negus (*Laryngology*): Special Discussion on The Treatment of Chronic Non-tuberculous Infection of the Lungs.

Royal Institution of Great Britain, at 5.15.—Prof. R. Whytlaw Gray: Smokes as Aerial Disperse Systems (1).

Institution of Electrical Engineers (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—Prof. W. M. Thornton: What is Electricity? (Faraday Lecture).

Institution of Electrical Engineers (North-Western Centre) (Informal Meeting) (at Engineers' Club, Manchester), at 7.—J. H. Reyner: Recent Developments in Radio Reception.

Royal Photographic Society of Great Britain (Scientific and Technical Group), at 7.—Exhibition and Demonstration of Apparatus used in the Testing of Photographic Products, etc.:—Dr. F. C. Toy: A New Photo-electric Photometer.—S. O. Rawling: (*a*) An Electrode Vessel Jacketed for Use at Various Temperatures; (*b*) Method for Coating Photographic Emulsions as Single Layer Plates Without Dilution.—A. S. Newman: (*a*) A New Design of Microscope; (*b*) Apparatus for General Laboratory Use; (*c*) Sundry Workshop Appliances.—F. F. Renwick: A Turbidimeter for Use with Photographic Emulsions.—E. Farrow: An Apparatus for Determining the Relative Exposures with Various Light Filters.—R. Davies: A Selenium Cell Photometer Adapted for the Determination of Reflection Densities with an Automatic Curve Plotting Device.—T. Thorne Baker: Apparatus for the Telegraphic Transmission of Photographs, at Work over an Artificial Line Equivalent Electrically to Paris–London.—W. A. Balmain and L. F. Davidson: An Intensity Scale Apparatus Improved so as to render it possible to Expose Several Strips of Plates Simultaneously.

Institution of Engineers and Shipbuilders in Scotland (at 39 Elmbank Crescent, Glasgow), at 7.30.—Rev. R. R. Hyde: The Development of Industrial Welfare Work.

Royal Anthropological Institute (Anniversary Meeting), at 8.30.—H. J. E. Peake: The Beginnings of Civilisation (Presidential Address).

WEDNESDAY, January 26.

Newcomen Society for the Study of the History of Engineering and Technology (in Demonstration Room, A 1, Science Museum, South Kensington), at 5.30.—A. Titley: Trevithick and Rastrick and the Single Acting Expansive Engine.—Rhys Jenkins: A Note on Newcomen's Handwriting.

Institution of Automobile Engineers (North of England Centre) (at Engineers' Club, Manchester), at 7.—Prof. W. Morgan: The Optical Indicator as a Means of Examining Combustion in Internal-Combustion Engines.

North-East Coast Institution of Engineers and Shipbuilders (Graduate Section) (at Newcastle-upon-Tyne), at 7.15.—J. E. Conner: The Erection of a Rotary Portland Cement Kiln.

Institution of Automobile Engineers (Wolverhampton Centre) (at Engineering and Scientific Club, Wolverhampton), at 7.30.—G. Rushton: The L.G.O.C. Methods of Repairing Motor Omnibuses.

Society of Chemical Industry (South Wales Section) (at University College, Swansea), at 7.30.—Capt. J. R. Green: Quantitative Spectrographic Analysis in Metallurgy.

Royal Society of Arts, at 8.—F. W. Spencer: British and American Practice in Hot and Cold Working of Metals.

Faraday Society (at Chemical Society), at 8.—J. B. O'Sullivan: The Behaviour of the Quinhydrone Electrode in Solutions of Neutral Copper Sulphate.—W. Taylor: The Actinic Absorption of Chlorine Gas with Respect to the Hydrogen Chlorine Reaction.—W. Taylor and A. Elliott: The Residual Effect in the Actinic Absorption of Chlorine.—W. R. Harrison and E. P. Perman: Vapour Pressure and Heat of Dilution of Aqueous Solutions. Part II.—N. A. de Bruyne and R. W. W. Sanderson: The Electrostatic Capacity of Aluminium and Tantalum Anode Films.—G. A. Elliott, S. S. Joshi, and R. W. Lunt: On the Velocity of Chemical Reaction in the Silent Electric Discharge.—G. A. Elliott: The Activation of Hydrogen in the Electric Discharge.—C. C. Tanner: The Soret Effect.—H. I. Downes and E. P. Perman: An Improved Method of Measuring Vapour Pressure by Air Bubbling.

British Psychological Society (Medical Section) (at Royal Society of Medicine), at 8.—Dr. T. S. Good: An Attempt to Investigate and Treat Cases of Psycho-neuroses and Psychoses at an Out-Patient Clinic; followed by a discussion by Dr. E. Mapother, Dr. H. Crichton Miller, Dr. J. Rickman, and others.

Eugenics Society (at Royal Society), at 8.30.—H. Macdonald: Social Distribution of Intelligence.

Institution of Mechanical Engineers (Sheffield Branch) (at Sheffield).—B. W. Tipple: Machine Tools.

THURSDAY, January 27.

Royal Society, at 4.30.—L. A. Harvey: The History of the Cytoplasmic Inclusions of the Egg of *Ciona intestinalis* (L.) during Oogenesis and Fertilisation.—S. Dickinson: Experiments on the Physiology and Genetics of the Smut Fungi. Hyphal Fusion.—Dr. J. W. H. Harrison: Experiments on the Egg-laying Instincts of the Sawfly *Pontania salicis* Christ. and their Bearing on the Inheritance of Acquired Characters, with some Remarks on a New Principle in Evolution.—S. A. Asdell and Dr. F. H. A. Marshall: The Effect of the Ovarian Hormone in producing pro-Œstrous Development in the Dog and Rabbit.—E. Ponder: The Measurement of Percentage Hæmolysis. II.

Royal Institution of Great Britain, at 5.15.—J. R. H. Weaver: Romanesque and Early Pointed Architecture in Spain (2).

South London Entomological and Natural History Society, at 7.—Annual Meeting.

Institution of Automobile Engineers (Luton Graduates' Meeting) (at Luton), at 7.30.—G. L. Ensor: A Practical Experience of the Single Sleeve Valve Principle.

FRIDAY, January 28.

Royal Society of Arts (Indian Section), at 4.30.—Sir Leonard Rogers: The Forecasting and Control of Cholera Epidemics in India.

North-East Coast Institution of Engineers and Shipbuilders (at Newcastle-upon-Tyne), at 6.—G. S. Baker: The Economy of Tank Testing of Ship Forms and Research in Ship Propulsion.

Institution of Locomotive Engineers (Manchester Centre) (at College of Technology, Manchester), at 7.—S. Symes and others: Discussion on Mass Production as applied to the Repairing of Locomotives.

Royal Photographic Society of Great Britain, at 7.—H. Lambert: Lighting in Portraiture.

West of Scotland Iron and Steel Institute (at Royal Technical College, Glasgow), at 7.—Sir William Larke: Address.—Prof. A. L. Mellanby and Prof. W. Kerr: Use and Economy of High Pressures in Steam Plants.

Junior Institution of Engineers, at 7.30.—C. H. Atkinson: The Design of High Tension Sub-stations.

Royal Sanitary Institute (in Small Town Hall, Reading), at 7.30.—Discussion on Cancer:—Sir Stewart Abram: From the Point of View of the Physician and the Public Authority.—Dr. T. S. Keith: Cancer Research To-day.—J. L. Joyce: The Present Position of the Treatment of Cancer.

Royal Institution of Great Britain, at 9.—Prof. E. P. Cathcart: The Physique of Women employed in Industry.

Manchester Literary and Philosophical Society (Chemical Section).

SATURDAY, January 29.

North of England Institute of Mining and Mechanical Engineers (at Neville Hall, Newcastle-upon-Tyne), at 3.—P. F. Hope: Steam and Electric Locomotives for Colliery Purposes.

Royal Institution of Great Britain, at 3.—Prof. E. W. Tristram: English Mediæval Wall-Painting (1).

PUBLIC LECTURES.

SATURDAY, January 22.

Horniman Museum (Forest Hill), at 3.30.—Mrs. H. M. Dunn: Benares, the Sacred City.

SUNDAY, January 23.

Guildhouse (Eccleston Square), at 3.30.—S. N. Mallik: Hinduism.

MONDAY, January 24.

University College, at 6.—Dr. H. D. Jennings White: Science and Poetry.

THURSDAY, January 27.

King's College, at 5.30.—Dr. F. A. P. Aveling: The Mind: Psychology.

Northampton Polytechnic Institute, at 7.—R. Genders: Steel and its Thermal Treatment: The Heat Treatment of Carbon Steels.

Fulham Central Public Library, at 8.—A. S. E. Ackermann: Popular Fallacies.

SATURDAY, January 29.

Horniman Museum (Forest Hill), at 3.30.—Miss M. A. Murray: Some Invasions of Ancient Egypt.

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Trusts and National Progress.

THE nineteenth century was known as the 'steel' age. Attempts to find a word to describe the present age have not succeeded. 'Chemical,' 'wireless,' and 'flying' are adjectives which prejudge the issue of the fierce rivalry between chemists, physicists, biologists, psychologists, engineers to leave an impress on their day and generation. Pending a decision, it is safe to suggest that the present age is an age of 'surprises.' The War itself was a surprise—its outbreak to Great Britain, its result to our enemies; and many of the surprises which have followed that event with bewildering profusion are attributable to the War. We shall find a good example in the history of the 'trustification' of industry. Had anybody predicted before the War that the present year of grace would see the promotion of a great chemical combine—the Imperial Chemical Industries, Ltd.—with a nominal capital of £65,000,000, he would have been advised to consult a mental specialist. In the years preceding the War, the United States, under special legislation, was ruthlessly suppressing its powerful trusts as inimical to the public welfare. Is it possible that the stone which the American builder rejected should become the corner-stone of the British economic temple?

There were a few trusts in Great Britain before the War, together with their by-product in the form of millionaires—a few only, and these, unable to establish a monopoly, provoked no strong public opposition. To tell the truth, these trusts showed no disposition to grind unduly the faces of the poor. An occasional newspaper war regarding the price of soap or sewing-cotton served its immediate purpose of increasing the circulation of the newspaper, and may incidentally have reminded the manufacturer that there is a limit to the exploitation of the consumer. But the public at large showed no great interest in such questions, or indeed in kindred questions vitally affecting the public safety. As to the chemical industries, how many foresaw the importance these industries would assume in the prosecution of the War? It was known that the 'heavy chemical' industries were prosperous, but the dye industry, based on the discovery of an English chemist, had virtually acknowledged defeat. Some eighty per cent. of the dyes used in Great Britain before the War were imported from abroad, mainly from Germany.

"Trusts," says a well-known encyclopædia in the opening words of its article on this subject, "are large business organisations which aim at restricting or eliminating competition" In relation to the conditions, national and international, obtaining to-day, this definition is obviously partial and strabismal. Possibly it is the work of one of those economists whose predictions, as a speaker said at the British Association meeting last year, are generally falsified by events. We are asked to imagine an idyllic scene in which two competing manufacturers producing the same article, one to sell at 2*d*. per lb. and the other at 2¼*d*. per lb., decide to 'combine' and sell their total product at 2¼*d*. per lb. The position which the coal industry, the chemical industry, and other great British industries are facing to-day is more complex. "Amalgamations," says Sir Alfred Mond, the evangelist of the new economic gospel, "mean progress, economy, strength, prosperity." They are the bulwarks of defence for which the whole community has been patiently waiting, "offensive weapons against those enemies at home and abroad who are attacking insistently and insidiously the fortress of the national fortunes."

In cold truth we are entering on an economic war which will lead to the extinction of the less strong and efficient nations. This war will be fought out by large-scale and highly organised units; and the form of organisation ensuring the maximum of financial strength and stability, the minimum of duplication of plant and service, the concentration of the best brains available on the real problems of industry, the most effective methods of promoting scientific research and the application of scientific discoveries, will win the day. Already the amateur company director is beginning to spell out the writing on the wall, and scientific workers are at long last seeing their value appreciated by the industrialist. The question whether, in making our plans for this economic war, we are pursuing the best policy, tactical and strategical, is of direct and vital interest to every citizen.

This question has innumerable aspects, and some of these cannot appropriately be discussed in detail in a scientific journal. Political influences are obviously of the highest importance—not in the narrow sense of the form of government, Tory or Labour, which may happen to be in power at any particular moment. Direct and indirect government aid to scientific research, diplomatic and consular services, factory and patent legislation, monetary system, trade union regulation, health and unemployment insurance, and a hundred other influences are at work, promoting or hindering the progress of industry. Our educational organisation is a powerful influence both in raising the general average of intelligence and in selecting and training those 'captains of industry' whose silent moves on the chequer boards of manufacture and commerce may lead to disaster or victory. Industrial psychology is a new and important science, and 'the human factor' in industry will have to receive increasing attention. But labour difficulties have not caused serious trouble in the *scientific* industries —a good sign and omen.

The loss of the dye industry before the War, to which reference has been made, affords a good illustration of the working of some of these influences It is a twice-told tale reflecting no great credit on our Victorian forbears. Dr. Herbert Levinstein says:

> "If after the Franco-Prussian war *laissez-faire* had not been the policy of the State, a very different position would have resulted in this country. If the State had provided duty-free spirit on terms comparable to those enjoyed abroad; protection for inventions, and prohibition of import of dyes manufactured abroad; information concerning foreign products, and, above all, an assurance of a benevolent interest in the industry; do you think that Perkin and Nicholson would have left?"

The official apology of the British Dyestuffs Corporation harps on the same string and strikes a new note in pointing to the lack of systematic research and of facilities for training organic chemists. Our ancient universities, content in producing educated men of a particular type, adopted an attitude of indifference, or even of scorn, to the public demand for scientific education. The Government, dimly recognising the public need, did a useful service in establishing the Royal College of Science. But Hofmann, one of the most distinguished professors of that college, inspirer of those researches of Perkin which laid the foundation of the dye industry, was attracted back to Berlin, after the death of the Prince Consort: his companions followed him, and took with them much of the expert knowledge of aniline dyes. Ambassador Walter Page, in one of those illuminating letters written during the War to President Woodrow Wilson, which have raised our respect and affection for the United States, referred to some things which the Allies would do in "the war after the War." The Germans, he wrote, had used commercial and financial methods in England, and in Russia in particular, which were unmoral if not immoral—methods which might have been taken out of the book of a decade or so about the Standard Oil Company.

"They 'dumped,' and killed competition by starving out competitors. They conducted systems of commercial espionage, etc. etc. etc. The English were slow to detect these things, and sluggish to move against them. They will be neither slow to see nor sluggish to act for some time after the War. They will try, too, to prevent dependence on Germany for dyestuffs and other monopolised articles."

This prediction has been verified. Forming part of a great combine of the chemical industries, the British dye industry, a key industry as the War has shown, will be able to play a worthy part in "the war after the War."

Adequate finance is not, however, the only advantage which the new trust will offer to the dye industry. Of special interest, fully recognised by the promoters of the trust, is the question whether it will be possible to improve methods and results in scientific research. The record of the constituent companies in this respect is creditable enough, and the work they accomplished during the War earned the gratitude of the nation. But combination must tend towards greater economy and greater efficiency. Industrial research, as Dr. Levinstein has pointed out, can only be successfully conducted by great organisations. The expense of a scientific staff is too great to be borne by the average manufacturing concern of moderate size.

> "There is nothing so unprofitable," he says, "as employing a number of chemists who either have not the knack of discovering things for you, or who discover things for you that you have not got sufficient technical ability to work on a large scale, or for which you have not sufficient discernment to find a market."

The inventive chemist is generally a pure research chemist without knowledge of or interest in large-scale production. Are we not disposed to overlook the high and difficult character of the scientific, technical, and engineering work which transmutes the laboratory product into an article of commerce? For example, the combination of nitrogen and hydrogen under high pressure in the presence of a catalyst to produce ammonia was a reaction of academic interest until Haber pointed out to the Badische Company that the cost aspect would be altered if the ammonia could be separated from the compressed gases without the pressure being released. Even so, the working out of the process was a colossal undertaking, so complicated that Dr. Levinstein suggests that no firm in Great Britain could at the time have adopted the idea. We have good reason to know and to remember how the process enabled Germany to prolong the War by rendering that country independent of supplies of Chile saltpetre; and we have good reason also to be grateful for the enterprise of Messrs. Brunner, Mond and Co., who have overcome the technical difficulties and established at Billingham the synthetic nitrogen industry—an industry which will literally change the face of the earth, making the desert places smile and rejoice. The modern chemist can call spirits from the vasty deep.

> "Why, so can I; or so can any man:
> But will they come, when you do call for them?"

What is the chemist's reply to this searching Shakespearian question? He selects a very inert element in the air and turns it into manna to feed the multitude. In some instances, science is able to supersede natural processes. The synthesis of indigo by the Germans, one of the greatest triumphs of industrial chemistry, the result of prolonged and expensive scientific research, has thrown thousands of acres out of cultivation. Artificial silk has caused the silkworm 'to go out of business.' The men of science who work these miracles derive no stimulus from the lash of competition. By pooling our resources, spiritual and material, we may hope to obtain the best results and to compete on even terms with other highly organised nations.

We come, finally, to an aspect of the question on which Sir Alfred Mond rightly lays stress—the question of national psychology. We are suffering, he says, from the people who are always sitting round with the 'No' complex; people who dedicate their intellects to the congenial task of creating difficulties and objections to every proposed development; people who themselves achieve nothing except to hold up the march of progress of nations and industries. The only real advantage which America has over us, he suggests, is that the Americans welcome new ideas and are always ready to give them a trial. "You want more people with the 'Yes' complex," he says. "There is no room for the 'No' people: they must get out of the way or it will be a serious thing for this country." We have the men, the money, the material. "I am not in the least impressed," Sir Alfred Mond says, "with the technical superiority of any other people in the world." There are no abler chemists or engineers to be found; and our working men are "extraordinarily adaptable, highly skilled, and well trained." No miracle is required, no new dispensation from Heaven, to keep Great Britain in the forefront of industrial nations—only common sense, energy, and the spirit of research.

T. LL. H.

The Greek Conception of Theoretical Geometry.

The Thirteen Books of Euclid's Elements. Translated from the Text of Heiberg, with Introduction and Commentary, by Sir Thomas L Heath. Second edition, revised with additions. Vol. 1: Introduction and Books I., II. Pp. xii + 432. Vol. 2: Books III.-IX. Pp. vi + 436. Vol 3: Books X.-XIII. and Appendix. Pp. vi + 546. (Cambridge: At the University Press, 1926.) 70*s.* net.

THE preface to the first edition of Sir Thomas Heath's translation of Euclid's "Elements" begins with the following quotation from De Morgan: "There never has been, and until we see it we never shall believe that there can be, a system of geometry worthy of the name, which has any material departures (we do not speak of *corrections* or *extensions* or *developments*) from the plan laid down by Euclid." In 1908, when that edition appeared, the movement in favour of a text-book for schools that discarded Euclid's order and proofs was in full vigour, and, in reference to that movement, Sir Thomas Heath contented himself with saying: "It is, perhaps, too early yet to prophesy what will be the ultimate outcome of the new order of things; but it would at least seem possible that history will repeat itself and that, when chaos has again come into geometrical teaching, there will be a return to Euclid more or less complete for the purpose of standardising it once more."

The possibility suggested in 1908 may be asserted in 1927 as a probability, if not indeed a certainty. Among the many text-books that have appeared in recent years—and some of these have many excellent features—there is none that could possibly have induced De Morgan to change one word of the sentence quoted above. The revolt inaugurated by Ramus in the sixteenth century against the Euclidean system and in favour of the admission of many theorems as 'obvious' has its counterpart in recent times, and there are many signs that the inadequacy of the new system is being felt as decidedly now as in the earlier period. But whether there is to be a return to Euclid, more or less complete, or a continuance of the wider liberty prevailing at present, it is very desirable, indeed essential, that all who have charge of the teaching of geometry should make a real study of the development of the science, especially in its early stages, and its reduction to an ordered system in the writings of Euclid. Probably few, if any, desire a return to Euclid *simpliciter*, but, whatever be the attitude to Euclid's "Elements" as a text-book, it is quite impossible to form an adequate appreciation of the influence of mathematics on modern thought without a careful study of the Greek geometry; for such a study there is no better basis than these volumes of Sir Thomas Heath.

It is a tribute to the excellence of the first edition that, while numerous changes have been made in the second, chiefly due to the new knowledge gained in recent researches, these changes are comparatively small; but the revision has been very thorough, and many passages have been rewritten. The paging, however, has been preserved, so that the page-reference to any proposition is the same for both editions. Two new excursuses are appended to the first volume. The first of these is on "Pythagoras and the Pythagoreans," and discusses at greater length certain views that had been dealt with in the notes to Euclid I. 47; the second bears the title "Popular Names for Euclidean Propositions," the names being: *Pons Asinorum, Elefuga, The Theorem of the Bride, The Bride's Chair, Dulcarnon, Francisci Tunica, Goose's Foot* (*Pes anseris*), and *Peacock's Tail* (*Cauda pavonis*). Those to whom any of these names is unknown may be amused by trying to find a proposition that fits it.

Euclid was not the first to write a treatise on geometry, and doubtless many theorems were known and applied before any proof of them was systematically attempted. Unfortunately, the character of the early proofs is to a very considerable extent a matter of guess-work. The very excellence of Euclid's "Elements" swept away such earlier treatises as existed, and such information as we have of them must be extracted from later commentators; even these are chiefly known through Proclus, whose commentary on the first book of Euclid is thus of fundamental importance in the history of mathematics. If the text of Proclus is trustworthy, it is hard to believe that he was an able geometer, but he was a well-trained philosopher, and, we may assume, was familiar with the philosophical principles that lay at the basis of theoretical geometry. Be that as it may, it is on Proclus more than any other single writer that we are dependent for our knowledge of the conditions under which Euclid worked.

In the introductory chapters of vol. 1, Sir Thomas Heath gives a most illuminating discussion of the bearing on Euclid's system of the philosophical conceptions of the period antecedent to the composition of the treatise. Accurate scholarship, wide knowledge, and, of equal importance, calm and restrained judgment, mark the treatment of a subject that has been too often the occasion for rash assertions. A study of these chapters throws a strong light on the difficulties that are involved in the passage from 'practical geometry' to geometry as a science, and proves the practical sagacity as well as the mathematical ability of the writer of the "Elements." Euclid was no mere redactor; it may be, and probably is, the case that now and again he had not the courage to discard older statements, but it demanded genius of a high order to reduce the loose and vague generalities of earlier treatises to a system that is at once comprehensive and logically compact.

It is impossible to discuss these volumes in detail, but it may be said that to almost every proposition interesting notes are appended that, in their totality, form an excellent introduction to the history of geometry; the numerous references, if followed up, would form a fascinating study and do much to make the geometry lessons more interesting to pupil and teacher alike. The inclusion of Euclid's arithmetical books is specially welcome, and one may express the hope that the tenth and thirteenth books may now become something more than names to all who are interested in geometry; nowhere is Euclid's genius better seen than in these books. But the most ardent adherent of Euclid would scarcely object to the simplification that is introduced by modern symbolism in an elementary treatment of the constructions in Book XIII.

It is almost impossible to praise too highly the selection from the overwhelming material with which Sir Thomas Heath had to deal or the luminous exposition of many difficult topics; his mastery of English is nowhere better shown than in the translation of the text, where the flavour of the original is never lost, and yet due respect is paid to the English idiom. The only *caveat* I would make is that, at times, there is a tendency to read too much into the Greek texts. For example, I find it impossible to assent to the statement (vol. 1, p. 220) that Playfair's postulate "is distinctly stated in Proclus' note to Eucl. I. 31." It is one thing to *prove* that, with Euclid's postulate, there is only one parallel through a given point to a given straight line (and this seems to me to be at most what Proclus does); it is quite a different thing to reverse the process, and this is the essence of Playfair's procedure. Playfair, of course, does not claim the credit of the axiom; he says that the axiom "has been assumed by others, particularly by Ludlam." Who are the others? I do not know, but Playfair's discussion seems to show that he at least did not see it in Proclus. There are other cases in which I think too much is read into the older treatises, but, after all, these considerations are largely matter of opinion, and the debt which mathematicians owe to Sir Thomas Heath is too great to justify more than a passing reference.

GEORGE A. GIBSON.

Festschrift Carl Schröter.

Veröffentlichungen des Geobotanischen Institutes Rübel in Zürich, Heft 3. Festschrift Carl Schröter. Gewidmet von seinen Freunden, Schülern und Kollegen. Im Auftrag des Schröter-Jubiläum-Komitee redigiert von H. Brockmann-Jerosch. Pp. viii + 811 + 28 Tafeln. (Zürich: Rascher und Co., 1925.) 30 francs.

ON December 19, 1925, Carl Schröter, still "Professor der Botanik an der Eidgenössischen Technischen Hochschule in Zürich," celebrated his seventieth birthday. A *Festschrift* of 811 pages, containing an account of Schroter's life and work by Rübel, a former student and present colleague, and forty-nine original articles by botanists of some thirteen nationalities, was published in honour of the occasion.

The influence of Carl Schröter has been great, not only on the institution in which he was first a student and afterwards professor for forty-two years, but also on the development of Swiss botany in general. Since 1882 his chief interest has been ecological plant geography, a study to which he was attracted by a perusal of Christ's "Pflanzenleben der Schweiz," and Kerner's "Pflanzenleben." His influence on the subject to which he has devoted his life can be compared with that of Schimper and Warming. He has been an indefatigable investigator, a mere list of his publications occupying some thirteen pages of the *Festschrift*. His published researches, independent or in collaboration, include many important studies on the vegetation of Swiss grasslands, moorlands, and lakes, while his extensive knowledge of alpine plants is summed up in his well-known "Pflanzenleben der Alpen," now in its second edition.

Schroter's influence, however, has been due even more to his personality as a man and a teacher than to his writings. Above all, he is intensely human. Tansley, in his article in the *Festschrift*, refers to "the distinguished and beloved founder of the Zürich school, who has contributed so much by example and personality to international understanding and co-operation." The secret of his success in this respect may be summed up in the words of Rübel, "Für ihn liegt der Zweck des Lebens im Geben." In the lecture room, laboratory, and not least in the field, Schröter always gave of his best to his students, and in return received from them unswerving loyalty and devotion. Thanks to Schröter's inspiring leadership, the Zürich school of plant geography (or that branch of it known as plant sociology) is now one of the most active centres in the world for the study of natural vegetation.

Schröter's keen love of Nature led him to take a most active part in the Nature Reserve movement. He was one of the founders of the magnificent Swiss National Park, on which he contributed an article to NATURE (vol. 112, p. 478, 1923), and he selected it in April of last year as the subject of his Hooker lecture to the Linnean Society of London. His reverence for Nature was brought home to me some years ago as he and I stood together near the Kleine Scheidegg. Glancing from the Jungfrau and the Mönch, bathed in sunshine, to the modern hotels in the foreground, Schröter exclaimed with intense feeling, "It is a desecration."

In the pursuit of his ecological studies Schröter has travelled widely. From the first he made field excursions a special feature of his botanical teaching. Zürich students are fortunate in having the Alps, "The Playground of Europe," at their very doors. But sometimes more distant excursions, for example, to Corsica or Algeria, are organised. In this respect British botanical schools have hitherto been less enterprising than the Swiss and some American schools. Schröter himself has visited many parts of Europe, the Sahara, the Canary Islands, the United States, and in 1898–99 travelled round the world. Even now, in his seventy-first year, he is absent on a year's journey to South Africa, India, and the Far East.

It is impossible within the limits of a review to do more than indicate something of the scope of a few of the articles contributed to the *Festschrift* by botanists of many lands. The articles are grouped into eight sections according to subjects.

In the first section are fifteen papers dealing with Alpine and Arctic vegetation. Rübel (Zürich) shows that many of the plants of high Alpine meadows hibernate under deep snow in a green condition. Evergreen meadows are not confined to the lowlands. Du Rietz' (Upsala) work on the altitudinal ranges of plants of northern Lapland appears to suggest that edaphically indifferent common species may be important as indicators of climate. Rikli (Zürich) resolves the Alpine-Arctic flora into elements derived from various distributional centres, and discusses probable routes of migration. Flahault (Montpellier) gives a general account of wind and snow as ecological factors. He instances cases of young conifers buried under winter snow being killed, not by cold, but by asphyxiation brought about by overlying layers of snow and ice.

The second section (nine papers) is devoted to extra-Alpine vegetation. Tanfiljef (Odessa) describes the natural alluvial meadows (Auen) of Russia. Much of the grassland of western Europe is at best only semi-natural, but true natural meadows occur in river valleys in east Europe and Siberia. The treelessness of the valley meadows of northern Russia is attributed to the prolonged waterlogging of the soil, and to the velocity of the ice-covered rivers, when the melting snow floods the valleys in springtime. Morton (Vienna) discusses the flora of caves from the physiological viewpoint. Blue-green and green algæ in particular are extremely tolerant of shade, some retaining their chlorophyll after years of cultivation in darkness. "The Structure of Woodlands" by Salisbury (London) deals with the stratification of woodland vegetation in relation to gradients of atmospheric and soil conditions. Four types of undergrowth species are distinguished, according to the time of development and duration of the assimilating organs. MacDougal (Arizona) describes the rapid changes in vegetation of an area adjacent to the Gulf of California, consequent on draining and increasing salinity. Podpěra (Brünn), in a paper on the origin of present-day European forests, groups Eurasian forests into Tertiary forests, Relict forests, the Eurasian Taiga and the dwarf forests of high mountains and Tundra. Miocene aridity and Pleistocene glaciation have profoundly modified the original Tertiary forests. Tansley (Cambridge) analyses the vegetation of the English Chalk. He emphasises the important point, ignored in the early days of ecology, that vegetation cannot be understood unless it is investigated from the developmental point of view as well as from that of habitat factors.

The third section of the book contains four papers by Pavillard (Montpellier), Chodat (Geneva), and others, on phyto-plankton.

The fourth part has five papers on phyto-palæontology and historical plant geography. Neuweiler (Zürich), from evidence afforded by fossil woods, concludes that from Palæolithic to Roman times the Swiss forests north of the Alps contained 82·3 per cent. of deciduous trees, and only 17·7 per cent. of conifers. He criticises, quite justly, statistics based on the modern pollen analyses of peat. Herzog (Munich) finds, in a study of the geographical relations of the mosses of south Brazil, strong support for the hypothesis of Wegener and others, that the continents of Africa and South America were formerly continuous.

Section 5, on systematic botany and genetics, contains one short paper by de Vries (Holland) on the quest for the origin of species, and five other papers.

Under the heading "Soziologische Begriffe" (Section 6) are four papers, two of which deal with the struggle for existence amongst plants. Cajander (Helsingfors) adduces convincing evidence that the limits of natural distributional ranges of species. The sharpness of the boundaries of particular plant communities, as well as the definite structure of these communities, are largely determined, in the last resort, not by climate or soil, but by the mutual struggle for existence. Yapp (Birmingham) analyses the probable inter-relationships of plants in vegetation, and introduces the new concept of 'priority' as distinct from competition. Priority amongst plants is the passive interception of supplies of a necessity by an organism which is more favourably situated than another.

Section 7 on anatomy and physiology contains one paper by Jaccard (Zürich) on the weeping ash, and the final part (Section 8), five papers on economic botany.

From this brief résumé it will be seen that most of the papers have a direct or indirect bearing on the comprehensive subject of plant geography. Many reach a high level of importance, and not a few are concerned more with general principles than with details. The volume distinctly enriches the literature of plant geography. It has been well edited by Brockmann-Jerosch on behalf of the Schröter-Jubiläum-Komitee, and is well printed and illustrated. The *Festschrift* forms a sincere and fitting tribute to a singularly winning personality.

R. H. YAPP.

The New Wireless Technique.

The Theory and Practice of Radio Frequency Measurements: a Handbook for the Laboratory and a Textbook for Advanced Students. By E. B. Moullin. (Griffin's Scientific Textbooks.) Pp. xi + 278. (London: Charles Griffin and Co., Ltd., 1926.) 25*s.* net.

IT is difficult for a wireless worker of to-day, who has been trained along modern lines, to realise how much precision has been introduced into his subject by the development of the thermionic valve. Important radio measurements were made in pre-War days, but in every case strong signals had to be used. The difficulties were largely due to the relative insensitivity of the instruments available for the measurement of high-frequency currents and potentials. But this, of course, did not prevent the pioneers of those days from making the very best use of the instruments at their disposal, and more than twenty years ago Duddell and Taylor, in a classical series of experiments, laid the foundations of the subject of signal measurement by studying the falling-off of signal intensity with increase of distance from a radio transmitter. In these experiments the high-frequency currents produced in a receiving antenna were measured directly with a Duddell thermogalvanometer. Although audible signals were detectable at much greater distances, quantitative observations were possible only up to a distance of 80 miles. In signal strength measurements over long distances, subjective methods involving audibility comparisons had to be used which were not very trustworthy.

The development of the thermionic valve has changed all this. It has supplied us with transmitters of electric waves which are remarkably constant in amplitude and frequency. It has made possible the building of stable amplifiers by means of which small oscillatory currents and potentials may be magnified to sufficient volume to affect our alternating current measuring instruments. Finally, in the tube itself we have a high-frequency voltmeter of precision.

The absence of a comprehensive account of the methods and devices now at the disposal of the wireless engineer and research worker has been felt for some years, and we are grateful to Mr. Moullin for undertaking the task of writing one. His work cannot have been easy. The setting-up of a wireless set, to receive signals, is easy, as every schoolboy knows, but once the word 'measurement' is introduced in connexion with high-frequency phenomena, difficulties begin to appear. None of these difficulties has been shirked by Mr. Moullin. Throughout his volume the physical principles are clearly interpreted, and every page bears witness to his wide experience in dealing with students' difficulties. As an example of this we may quote the practical details and advice he gives concerning the use of low-power valve generators for laboratory experiments. The instructions he gives for designing, setting-up, and adjusting for maximum output a valve generator to meet given requirements could scarcely have been improved.

The older books on wireless telegraphy have dealt with measurements of high-frequency resistance, capacity, and inductance, but Mr. Moullin has much to say that is new. In the sections on the measurement of frequency and of signal intensity all the newer methods are given, including an account of Mr. Dye's very important work on the multi-vibrateur. In view of the importance of the use of quartz crystals as frequency controllers in a wireless spectrum already crowded, it is unfortunate that the work of the same author on this subject was published too late to be included.

There is no doubt that Mr. Moullin's book will be widely read by wireless engineers, but we must very reluctantly point out that the price of the volume is too high for it to be used as a text-book in university classes and thus assist in missionary work among the younger generation of physicists. E. V. A.

Our Bookshelf.

Handbuch der biologischen Arbeitsmethoden. Herausgegeben von Prof. Dr. Emil Abderhalden. Lieferung 204. Abt. 9: *Methoden zur Erforschung der Leistungen des tierischen Organismus,* Teil 1, Hälfte 2, Heft 2. Spezielle Methoden: *Tierhaltung und Tierzüchtung.* Pp. 215 + 484. (Berlin und Wien: Urban und Schwarzenberg, 1926.) 12·30 gold marks.

NOTICES of successive fascicules of this comprehensive work edited by Prof. Abderhalden have frequently appeared in our columns. The present instalment is concerned with the biology of insects and the technique of breeding and rearing those animals for purposes of scientific observation. Several groups have already been dealt with in Lieferung 182, and in the part before us most of the larger orders are considered.

Dr. C. Börner discusses the Homoptera with special reference to the aphides. His contribution includes a useful list of numerous members of the latter group in different parts of the world, with their known primary and secondary hosts. This is followed by a section dealing with the transmission of mosaic and other plant diseases through the agency of various Homoptera. The Lepidoptera are dealt with by Dr. E. Fischer, whose account is divided into two parts. The first is concerned with methods of collecting, and is followed by a larger section on the technique of rearing, including pairing, counteracting disease, and conducting experiments under varying conditions of heat and cold.

Dr. F. Heikertinger contributes the chapters on Neuroptera, Trichoptera, Mecoptera, Coleoptera, and Diptera. The accounts of the last two orders mentioned are in considerable detail, each family being considered separately. The concluding part is on Hymenoptera, by Dr. J. Fahringer. This is more curtailed than the preceding sections, and we think might have been expanded to advantage considering the specialisation of technique often required, especially with regard to the parasitic members of the order. A. D. I.

Chemistry and Recent Progress in Medicine. By Prof. Julius Stieglitz. (The Johns Hopkins University School of Medicine, The Charles E. Dohme Memorial Lectureship, Second Course, 1924.) Pp. viii + 62. (Baltimore, Md.: Williams and Wilkins Co.; London: Baillière, Tindall and Cox, 1926.) 7*s*. net.

THE subject matter of this little volume is indicated by its title and does not follow any very novel path. The work referred to is mainly trans-Atlantic and its presentation suffers somewhat from the fact that more than a year has elapsed between the delivery of the lectures and their publication. About one-third of the book is devoted to the subject of oxidation, in which the author develops the theory that oxidation is a loss of one or more electrons, and reduction, correspondingly, their gain, by atoms or ions of the molecules taking part in the reaction; in this connexion reference is made to glutathione.

Among other applications of chemical or physico-chemical principles to medical problems to which reference is made, are the conditions necessary for the deposition of calcium phosphate in bone and the study of blood as a physico-chemical system. In the earlier part of the book the author reviews the progress made in preparing synthetic drugs for therapeutic purposes and in isolating the active principles of the internal secretory glands of the body. Among the substances mentioned were noticed ethylene as an anæsthetic, certain of the arsenical derivatives and dyes used clinically, the secretions of the pancreas, pituitary gland, and ovary, and the isolation of purified principles from antibacterial sera.

Heredity. By Prof. A. Franklin Shull. (McGraw-Hill Publications in the Zoological Sciences.) Pp. xi + 287. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1926.) 15*s*. net.

THE author, who is professor of zoology in the University of Michigan, states in his preface that this volume represents a course of lectures delivered for several years to large classes of students who were admitted "without prerequisite." Doubtless for this reason the presentation of the subject matter is more or less popular, and in consequence somewhat dogmatic and superficial. Besides the phenomena of heredity proper, it deals with such topics as problems of population, immigration, and eugenics. Though by no means a poor book, it is rather mediocre and lacking in distinction. Probably it is better adapted to the audience for which it was planned than to an English one, but if it should help to stimulate interest in such matters it will have served a good purpose.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

Wireless Communication and Terrestrial Magnetism.

Dr. Chree's letter in Nature of Jan. 15 alludes to the names which might be associated with that upper portion of the atmosphere the aid of which is so often invoked to account for many of the facts of wireless telegraphy. May I explain why I happened to choose the name "Heaviside layer" some sixteen years ago?

In the spring of 1902 I was writing from time to time on wireless telegraphy in the pages of the *Electrician*, and one day Mr. Tremlett Carter, the editor, showed me a letter from Mr. Oliver Heaviside which, while discussing other things, asked if the recent success of Mr. Marconi in telegraphing from Cornwall to Newfoundland might not be due to the presence of a permanently conducting upper layer in the atmosphere. I believe this letter was shown to various friends of the editor, but I think it was not published. The substance of the suggestion was repeated by Heaviside in his article in the new edition of the "Encyclopædia Britannica" which appeared in America and in England in 1902. The suggestion was gradually approved during the years that followed; and about 1910 I used the convenient name 'Heaviside layer' in a paper, to indicate the portion of the atmosphere that functions so usefully for the purposes of wireless telegraphy.

The existence of a conducting stratum in the atmosphere, and the probable connexion of the stratum with the aurora, must have been surmised by every observer of electric discharge in rarefied gases even before the date of Cavendish; and as Dr. Chree points out, Balfour Stewart suggested that a conducting layer might have to do with certain variations of the magnetic elements. Schuster, I believe, first gave definiteness and substance to this suggestion. Later, G. F. Fitzgerald calculated the period of electric oscillation of the earth supposed surrounded by a sharply defined conducting layer in the upper atmosphere, thus for the first time introducing the conception of a relationship between electric waves and an upper layer. But, so far as I know, there is as yet no evidence that the auroral layer is the same as the Balfour Stewart or Schuster layer, or that this is the same as the Fitzgerald layer, or that any of them are the same as the physically present layer called for convenience the Heaviside layer. Therefore it seems to me that to call the wireless layer by the name of Cavendish or Balfour Stewart or Schuster, or even Fitzgerald, would assume too much. Why not let well alone until there is proof that the Heaviside layer is the same thing as one or other of the hypothetical layers?

May I take this opportunity of referring to another matter. I wish to urge that full advantage should be taken of the solar eclipse next June for learning more about the Heaviside layer. The map given in Dr. Lockyer's excellent article in Nature of Jan. 15, leads one to suggest that a wireless transmitting station near London and another in the north of Scotland should be devoted to transmitting signals continually throughout the eclipse period, so that receiving stations scattered about Great Britain might observe the intensity of signals which have crossed the path of the moon's shadow. Galvanometric measurements of a continuous stream of waves from the transmitters would be the ideal type of observation; but aural observations of the intensity of a code signal, if the time of each observation were accurately registered, would also be valuable.

In the latter case the method devised by the British Association Committee for use in 1914 may be recalled. Each transmitting station—one in Russia, one in France, and one in Ireland—was assigned a sequence of Morse letters for continuous transmission, the sequence of letters being such that no succession was ever repeated. A chronographic record of the transmitted sequence was to be made at each transmitting station, and observers had no other task than to write down the letters heard, heavily when the signals were strong, lightly when they were weak.

It was hoped that analysis and comparison of the records would show the effect of the shadow cone on waves passing through it; but the War came, and the organisation which had been built up for making observations throughout Europe immediately collapsed. Would it be possible, on the occasion now approaching, to arrange similar wide-spread European observations of signals proceeding from a special station in the north of Scotland? Indeed, if short waves were used, observations at a number of selected distant points of the globe would probably yield highly interesting results.

W. H. Eccles.

142 St. James' Court,
Buckingham Gate, S.W.1, Jan. 17.

The Beginning of Agriculture.

May I be allowed to make a few remarks on some of the points to which reference is made in Prof. Elliot Smith's letter on "The Beginning of Agriculture" in Nature of Jan. 15, p. 81?

The observation that "The statement that barley was the staple article of diet in Egypt from the earliest pre-dynastic period has passed without any notice whatever during the last fifteen years," would scarcely be made by any one acquainted with ancient cereals. That barley was an important cereal in Egypt in pre-dynastic and dynastic times is quite certain, for samples of this grain from these periods are well known. Its importance, however, was shared with Emmer wheat (*T. dicoccum*), and from the frequent 'finds' of the latter, often mixed with barley, I think it is probable that both were of equal importance for a long period, after which other races of wheat probably derived from Emmer took foremost place in the diet of ancient Egyptian and Babylonian populations.

The opinion expressed in the letter of Prof. Netolitzky that wheat was not eaten by the pre-dynastic people of Egypt, if based, as it appears to be, on the results of his examination of the material taken from the intestinal tracts of the Naga-ed-Dêr specimens, is of little value. The microscopic analysis of Prof. Netolitzky revealed the presence of barley husks in this material, and the discovery was confirmed by Frau Gherasim. Wheat husks were not found, and their absence Frau Gherasim asserts "definitely establishes the fact that pre-dynastic people did not eat wheat." Such a conclusion, based on the evidence given, is, to say the least, unwarranted. Two explanations may be given of the absence of wheat husks in the intestinal material examined, namely, (1) the human beings concerned had not recently eaten wheat; (2) in barley the husks (glumes) are closely adherent to the grains, and portions of them are consequently consumed with them, whereas in wheat the husks or glumes are free from the grains and must be removed before the latter can be used as food. That the husks were removed from Emmer wheat before the grains were used in ancient Egypt is amply proved by the frequent discovery of dehusked grains and the separate empty husks.

In regard to the antiquity of Emmer in Egypt, the following samples have passed through my hands: (1) From an undisturbed site of Badarian people (3500 B.C. or 5500 B.C., Petrie), sent by Mr. Guy Brunton; (2) a sample sent by Miss Caton Thompson obtained from a settlement of the second prehistoric period, near Qau; (3) from straw-lined pits found in the Fayum area by Miss Caton Thompson and dated by Sir Flinders Petrie at least 10,000 B.C. With these Emmers, barley was also found, and in the excavations which revealed sample (3) were also found the naked grains of a race of wheat which cannot be determined with certainty.

During the last week I examined a sample of naked grains of wheat discovered by Prof. Langdon in a vase on the site of an old Sumerian house in Mesopotamia and estimated by him to date from a period at least 3500 B.C. These, in my opinion, belong to a variety of Rivet wheat (*T. turgidum*), a race showing affinities with Emmer and doubtless derived from it. This is the first authentic sample of Rivet wheat which I have seen from ancient Babylonia or Egypt.

The present distribution of wild barley and wild Emmer suggests that even in the beginning of agriculture, primitive man would have the choice of both, and I doubt if ever there was a time when barley only or Emmer alone was the cultivated cereal. All the trustworthy evidence we possess shows that both barley and wheat were grown by the earliest agriculturists of whom we have any definite knowledge, and it appears to me likely that by the time agriculture had become sufficiently advanced to provide for even a comparatively small population, the merits of both these cereals would have been well established.

Into the question whether civilisation originated in Egypt or Babylonia I am not competent to enter, but I may point out that unless climatic conditions have undergone considerable changes in these regions, it may safely be concluded that Emmer wheat and possibly barley were taken there from Syria and Palestine, where they occur in a wild state.

The origin of the all-important bread wheat (*T. vulgare*), which has almost entirely supplanted Emmer and barley as human food, remains obscure; so far as trustworthy evidence goes, it was unknown to the ancient Egyptians and appears to have been a discovery of agriculturists accustomed to a cooler and more northerly climate.

In conclusion, I should like to take the opportunity to urge that small samples, or as much as can be spared, of all ancient cereals, as well as other crops and their associated weeds, discovered by archæologists, should be sent to one central museum—Kew, the British Museum, or the University, Reading, where we have a collection of some 2000 species, races, and varieties of wheat grown annually—where they would be easily accessible for study by experts and their nature more accurately determined than is possible at present, scattered as they are in large and small museums throughout Europe. In the past the naming of ancient cereals, and the wheats in particular, has been appallingly inaccurate, and it is not an exaggeration to say that three-fourths of the published statements about their botanical nature are worthless and misleading, many of them having been made by persons who have had no knowledge of more than one race of wheat, and only recognised wheat grains as distinct from those of barley or oat.

JOHN PERCIVAL.

The University, Reading.

PROF. ELLIOT SMITH has done good service in publishing Prof. Netolitzky's letter in NATURE of Jan. 15, for many must have been puzzled by the discrepancy between the statements made in 1911, and have not had the advantage of the private information with which Elliot Smith very kindly provided me. Frau Hedwig Gherasim's paper has definitely established that barley, and not wheat, was the food eaten at their last meals by the pre-dynastic people of Naga-ed-Dêr, the contents of whose stomachs had been sent to her for examination. To say, however, that this discovery "definitely establishes the fact that the pre-dynastic people did not eat wheat," is more than the facts available warrant.

That barley was used, and presumably cultivated, by the pre-dynastic folk of Naga-ed-Dêr at an early period is quite clear, though precisely how early must remain undetermined until there appears the full report of the excavation of Cemetery 7000, with details of the grave contents. As this was explored in 1901 this publication is long overdue. It has generally been thought that wild barley, *Hordeum spontaneum*, did not grow in Egypt, and no actual occurrence of this plant has been reported. I am indebted, however, to my friend Dr. O. Stapf for the information that during the closing decade of the nineteenth century it was reported from two sites in Tripoli. It is probable, therefore, that at an earlier date it grew also in the north of Egypt. I should be glad, however, to learn the evidence on which Elliot Smith bases his statement that barley is found wild in the regions to the south and east of Egypt.

We can well believe, therefore, that wild barley was brought under cultivation by people living on the banks of the Nile or at the edge of the Delta. Whether they were the only people thus to cultivate wild barley, still more the first to do so, must remain for the present a matter of uncertainty.

Evidence of the occurrence of wheat before the time of King Sahure has been accumulating of late years. In the tomb of Zer, the third king of the first dynasty, Petrie found a carving in wood of an ear, which was at the time described as of 'bearded barley.' It is now accepted by all grain experts as being an excellent representation of an ear of Emmer (*T. dicoccum*). But wheat was known, too, in pre-dynastic times. It is true that the grain found by Legrain and Lampre with a contracted burial between Kawamil and Silsileh, and claimed by them to be Emmer, has been declared by Schultz to be barley, but in the winter of 1912–13 Prof. Peet found at Abydos a range of large pots which had been used for drying grain, and he pronounced them to be undoubtedly of pre-dynastic date. In these were small caked masses of carbonised grain. Some of these grains were examined by Prof. Harvey Gibson, who found them to be wheat (*T. vulgare*). Near by a similar series of pots were found, but containing no grain; these, however, held sherds of decorated pottery belonging to the Middle Pre-dynastic Period.

One may, perhaps, question the identification of this grain as *T. vulgare*. All the grains from Dynastic Egypt so far found have been Emmer, or members of the *dicoccum* group. So far as we know, *T. vulgare* first made its appearance in Egypt in Roman times. It is by no means easy for one who is not a grain specialist to distinguish between *T. vulgare* and *T. dicoccum* in the carbonised state, but Prof. Harvey Gibson is too good a botanist to have mistaken barley for wheat. It is very desirable, however, that this carbonised sample should be submitted to grain experts for determination.

It would appear, then, that during the Middle Pre-dynastic Period, wheat of some kind, almost certainly *T. dicoccum*, was cultivated at Abydos. Yet no one has claimed wheat as native to Egypt. The distribution of wild Emmer, *T. dicoccoides*, is fairly well established; it ranges from Mount Hermon in Syria to the mountains of Moab. A single plant was found by Strauss in the Zagros mountains between Bagdad and Kermanshah. It would seem, therefore, that wheat and the practice of cultivating it must have been introduced from Asia. May not the cultivation of barley have been similarly introduced, for wild barley has a wider distribution in Asia than in Africa?

I have not yet seen Prof. Breasted's new book, but the passage quoted by Elliot Smith is rather surprising. The tablets he refers to are evidently the Nippur tablets and the Weld-Blundell prism. When publishing the latter, Langdon deduced from it that the date of the first dynasty of Ur was about 4000 B.C., though at the last moment in the preface he reduced this by fifty-six years. If from the same source Prof. Breasted deduces that the date of this dynasty is about 2900 B.C., it is clear that these tablets do not determine the maximum age of the earliest written documents with precision. The difference of more than a thousand years is not negligible.

It is quite likely that the second layer at Susa is contemporary with the first dynasty of Ur. The lowest layer, which contained the painted pottery, was succeeded by another layer containing a different type of ware, and this again by a sterile layer, 1 to 2 metres in thickness, before the layer known as Susa II. was deposited. How long it would take for such a thickness of soil to accumulate on an unoccupied hillock it is impossible to compute, but it is clear that the people of Susa I., who were cultivators of grain, lived very long before the first dynasty of Ur.

One sentence in Elliot Smith's letter has somewhat surprised me: "We know that people lived in Egypt at this time, many centuries before the metal copper was known." It is usually conceded that copper objects occur, rarely it is true, in the very earliest predynastic graves; moreover, Brunton has told us that in graves of the Badarian culture, which are earlier still, he found beads made of narrow copper ribbon and a stout copper pin or borer.

I should like to explain that the reason why the facts adduced by Elliot Smith relating to the early use of barley were not mentioned in recent discussions at meetings of the British Association and at the Royal Anthropological Institute was not that they were unknown to many of those present, but that both discussions were confined to the early cultivation of wheat in Egypt, and the question of barley did not arise. I trust, however, that these few lines, giving items of information apparently not very well known, may help to remove some of the widespread misunderstanding of which Elliot Smith quite rightly complains. I hope to deal with the question more fully at the Royal Anthropological Institute next week.

HAROLD J. E. PEAKE.

Westbrook House,
Newbury, Jan. 17.

Biological Fact and Theory.

ON returning from a holiday, my attention has been directed to an attack upon my book "The Physiology of the Continuity of Life," which appeared in NATURE on Dec. 25.

Fortunately an author is not expected to defend himself from criticism, just or unjust, but there is one point in the article which requires attention. The reviewer quotes the statement, "The F_2 shows all gradations from bar-eye to normal eye," and calls upon me to withdraw it. The words occurred as one of the following sentences:

"There are many examples of failure to show the clear-cut differentiation expected in the F_2 generation: Morgan cites the case of the cross between the normal and bar-eyed *Drosophila*. The F_1 generation is intermediate. The F_2 generation shows all gradations from bar-eye to normal eye. Here the segregation does not seem to be complete."

Morgan's words in his "Physical Basis of Heredity," page 31, are: "A mutant eye shape of *Drosophila*, called 'bar' (Fig. 7, *a*), has an intermediate hybrid type (Fig. 7, *b*). The F_2 group may be represented (Fig. 8) in the following scheme:

"Fig. 8.—Relation of bar-eye to normal eye, as shown by the F_2 classes.

In this case the hybrid, intermediate type overlaps the bar type, so that in F_2 these two latter types give a nearly continuous class. At the other end of the F_2 series the round-eyed normal (or wild) type can be distinguished without difficulty from either of the other classes."

I think that my interpretation is justified.

D. NOËL PATON.

University of Glasgow,
Jan. 7.

PROF. PATON's letter is another instance of what I complained of in my review—failure to grasp the fundamentals of genetics before proceeding to attack and criticise its conclusions.

What are the facts about bar-eye as revealed by Prof. Paton's quotation from Morgan? They are: (1) That bar is a partial dominant; (2) that the variability of the heterozygote is greater than that of either homozygote; (3) that the heterozygote's eye-type overlaps that of the dominant; (4) but that it does *not* overlap that of the recessive (wild-type or round eye).

Three further important points not quoted by Prof. Paton are as follows: (5) In F_2 the frequency curve for facet-number (eye-size) is definitely trimodal. There is a discontinuity between the round-eye mode and the rest; but the "nearly continuous class" comprising bar and heterozygote types shows two well-defined modes. (6) The overlap only occurs in the females. This, however, does not mean that the males show segregation, the females not, but is of course due to the fact that no heterozygous males can exist, since Bar is sex-linked (the frequency curve for males alone is therefore bimodal, while that for females alone remains trimodal). (7) We can therefore, as regards overlap, consider only females. But if *any* female from the "nearly continuous class" be taken and crossed with a wild-type (round-eyed) male, one of two results will invariably be seen in the female offspring: either (*a*) they will all be of heterozygous type, with a unimodal frequency curve; or (*b*) they will be half round-eyed and half of heterozygous type, *with no overlap*. Further (*c*), if enough individuals be tested, the ratio of those giving result (*a*) to those giving result (*b*) will approximate 1 : 2.

This can only be explained if the female parents are either of constitution BB or Bb, and that therefore segregation did occur in the germ cells of F_1, as well as in their own germ cells.

Even apart from these additional points, however, the quotation from Morgan definitely shows that segregation exists. For F_1 was all of the heterozygous type, not overlapping with the recessive round eye; and yet in F_2 this recessive wild-type eye was recovered pure, and without overlap!

It should, however, be strongly emphasised that this question of phenotypic overlap has of itself nothing to do with the question of segregation; and this is the graver error into which Prof. Paton appears to have fallen. Segregation—I also quote from

Morgan ("Mechanism of Mendelian Heredity," p. 1)—consists in this, that "the units contributed by each parent separate in the germ-cells of the offspring without having had any influence on each other." The *expression* of any unit in phenotypic characters will of course (again an elementary fact) vary with (*a*) environmental factors; (*b*) the presence or absence of other genetic factors affecting the same character (*i.e.* multiple or modifying factors). The overlap of the heterozygote type with that of one homozygote (which was of course complete in Mendel's original experiments) has *no bearing* on the question of segregation; nor indeed does its overlap with both homozygotes. In such cases, as Mendel showed sixty years ago, breeding tests must be used to discover the constitution of the organisms. For example, in Mendel's tall × dwarf cross there is considerable height-variation of the tall F_2 class (due to environment); but breeding-tests to F_3 (or back-crosses as in my point (7)) show at once that all the tall individuals are either pure talls (TT) or heterozygotes (Tt); some TT's will be taller, others shorter, than the average Tt, and vice versa. The same procedure will prove segregation even when the heterozygote phenotypically overlaps both homozygotes.

I must apologise for going into such elementary facts in the columns of NATURE; but I can only repeat what I said in my review, that the course of biological progress is impeded when distinguished men in positions of authority attack whole disciplines of biology without having understood their data and principles sufficiently well to avoid elementary mistakes.

It may, in conclusion, be mentioned (what again Prof. Paton appears not to be aware of) that in the last few years Zeleny and his pupils have shown, by using purified inbred stock under well-standardised environmental conditions, that the high variability of bar-eye and its heterozygote depends partly on temperature during a 'critical period' of development, partly on specific modifying genes. The pure stock under standard conditions loses the large phenotypic variability described by Morgan, just as a chemical substance ceases to behave irregularly when purified and when experimental procedure is improved.

In this purified stock at 25° C., the mean facet-number (which is directly proportional to eye-size) for females of the classes in question is as follows (Morgan, 1925, "Bibliographica Genetica," vol. 2, 31-32):

Homozygous bar (pure stock or extracted in F_2)	68
Homozygous round-eye (pure wild-type or extracted)	779
Heterozygous bar (F_1 or F_2)	358

It is obvious to my mind that Mendelian theory is far from complete. We know, *e.g.*, very little about the way genes act during development to influence phenotypic characters, and still less about the causes of mutation. But progress will be achieved by building on the ample foundation already obtained by tens of thousands of breeding-tests, not by going elsewhere to erect a superstructure without adequate foundations.

J. S. HUXLEY.

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Strand, W.C.2.

IN NATURE of Dec. 25, there appears a long review of Prof. Noël Paton's book, "The Physiology of the Continuity of Life," by Prof. Julian Huxley, who criticises the book severely because its author attacks from the point of view of the physiologist the whole edifice of the theory of genes or factors in heredity. I do not propose to intervene in order to support Prof. Paton, who is perfectly capable of defending himself, but Prof. Huxley has seen fit to attack the work of Tornier and to blame the author, and incidentally myself, for holding that it has any bearing on the question of heredity. It was I who gave to Prof. Huxley the references to Tornier's work, and I hold that this work is the most important, and indeed the only work on the causes of mutations which has yet appeared, and that it is worth all the factorial analyses put together. As this work is little known to readers of NATURE, may I briefly summarise its principal features?

Tornier investigated the conditions under which 'fancy races' of goldfish were bred in China, which is the original home of the species. He found that there was nothing recondite in the methods of these breeders; the fish were exposed to insanitary conditions and deposited spawn in these circumstances. The greater part of the eggs died. What survived gave rise to fish of varying degrees of abnormality, and *when these fish were bred these abnormalities were transmitted in some degree to their offspring*. By selection, a reasonably 'pure' 'fancy' could be produced in a few generations.

Tornier analysed the physiological causes of the development of these abnormalities, and showed that they could be reduced to a weakening of the developmental energy of the germ at a critical period of development, and that this weakening was transmitted to posterity and produced in each generation the same results. He imitated as nearly as possible the Chinese breeders' methods with the eggs of Amphibia and got similar abnormalities. He does not give details of experiments on breeding, but he expressly states that all these abnormalities are inherited. Anyone who asserts that Tornier's experiments have no bearing on the inheritability of mutations is, in my opinion, wilfully blind.

As to the inheritance of acquired characters, which is the other great factor in inheritance, Prof. Huxley refers to Dr. Noble's communication to NATURE of Aug. 7 on the subject of Kammerer's Alytes as if that closed the controversy. He does not refer to my answer to Dr. Noble. Since I wrote this, however, new light has been shed on this painful matter. The American journal *Science* has published verbatim the last pathetic letter which Kammerer wrote. In this letter, addressed to the University of Moscow, he explains the reason for his intended suicide. He gave full permission to Dr. Noble to examine his specimen of Alytes, believing that it would prove conclusive. He was greatly shocked at Dr. Noble's conclusion that it had been 'doctored' with Indian ink. He examined it himself and confirmed Dr. Noble's finding, and sadly acknowledged that the evidential value of this particular specimen had been destroyed. But he found also *that many others of his specimens on which Dr. Noble had not reported had been similarly treated*, and that all the fruit of his pre-War work, which would require twenty years to repeat, was gone. He did not feel the energy to begin all over again and so ended his life.

Dr. Przibram and the colleagues who knew Kammerer best, continue to have full confidence in him and are getting up a fund to perpetuate his memory. Perhaps Dr. Noble could throw light on the source from which he obtained the information that he would find the specimen of Alytes treated with Indian ink, as that might help us to discover the miscreant who, to damage Kammerer's credit, destroyed his life-work behind his back.

In conclusion, I should like to say to Prof. Huxley that the game of the mutationist opposition to

Lamarckism is up. Evidence in favour of Lamarckism is pouring in from all quarters. I direct his attention to the recent work of Metalnikoff in the Institut Pasteur, who, experimenting with the caterpillars of the genus Galleria, showed the inheritability of acquired immunity. This work was continued for nine generations under standardised conditions with adequate controls. E. W. MACBRIDE.

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South Kensington, S.W.7.

DURING the past twenty years I have made several contributions to the evidence in favour of the chromosome theory of heredity, the last in 1926. I am not nearly so sure as I was of the universal validity of that theory, and I hope that even in my callow youth I was never so dogmatic about it as is Prof. J. S. Huxley in his review of Prof. Noël Paton's book (NATURE, Dec. 25, p. 902). I feel that some protest should be made lest the constant repetition of certain dogmatic statements by Prof. Huxley and others of the same school should lead to a general belief that these statements represent proven facts accepted by all biologists who are familiar with this particular branch of knowledge.

When the mode of distribution of the chromosomes to the daughter cells during the production of the gametes is compared with the manner in which the Mendelian characters appear in breeding experiments, the coincidence seems at first sight to be overwhelmingly in favour of the chromosome theory, so much so that it appears to have blotted out every other point of view to many people. To me, however, it appears to give us no more than the right to assume that the appearance of certain characters or groups of characters may possibly be determined by certain chromosomes. Prof. Huxley has stated before, and states again in his review, that the "hereditary constitution of at least all higher organisms consists of a number of units (factors or genes), each of which may exist in a number of forms (allelomorphs); these genes exist in definite proportions, and are arranged in a definite order; the whole gene-complex is divided up amongst the separate chromosomes." He states these as proven facts which are thoroughly established, and not questioned except by those who are unaware of these claims, amongst whom he apparently places Prof. Paton.

Anyone who has dissected a chimpanzee must have been struck by the extraordinary similarity between its characters and those of man, similarities that extend to small branches of particular blood-vessels and nerves and to folds in the skin. If we believe in evolution of any kind we must believe that the bulk of our characters have come to us from remote prehuman ancestors through countless generations, all the individuals of which developed these characters in turn, and that the appearance of these characters depended upon their "hereditary constitution." I must point out, at the risk of being platitudinous, that it is only the capacity for developing a character under certain very limited conditions, and not the character, that is inherited.

Now to me it is difficult to imagine how all the characters in a complicated organism such as man can be conveyed by units or genes which are contained in individual chromosomes. The very mechanism that makes the theory fit so well with the appearance and disappearance of certain characters in successive generations in Mendelian experiments, is an obstacle when the fact is kept in mind that most characters are common to all individuals of the race. In the one case a given character appears in a certain proportion of the offspring and does not in the rest; in the other the character appears in all.

It may be claimed that what I describe as characters are not characters in the sense intended by Prof. Huxley. In what, then, are they different except in degree? To me it appears that the presence of a head, of ten fingers, extra digits, the colour of the eyes, the shape of the section of the hair, the colour of the skin, and such diseases as hæmophilia in man are all of them due to the hereditary constitution of the fertilised ovum and the action upon it of the environment. But it also appears to me that we cannot place all these characters in the same category as regards their mode of inheritance. Some might be due to units carried by individual chromosomes, others would of necessity appear to be conveyed by a potentiality in the cell elsewhere than in the chromosomes, when we consider how these are distributed during the production of the gametes.

My own belief is that the Mendelian mode of inheritance is confined to comparatively recent variations, and this belief is the more acceptable to me in that it provides for the ready elimination of the useless variations, as important a factor in evolution as the preservation of the useful.

I see that Prof. Huxley in his review limits himself to "at least all higher organisms" as regards his view of the chromosome theory, a limit I have not noticed that he has made previously. I quite appreciate why he has done this, but I think that it would have been wise to have pointed out that there is a number of organisms in which the distribution of the chromosomes is such that they could not possibly convey a Mendelian character (Dobell, *La Cellule*, t. 35, 1 fasc. 1924, and others.) This being the case, the function of the chromosomes in these organisms must be something entirely different from what it is in the higher organisms, to me an entirely unwarrantable assumption. CHARLES WALKER.

Television.

THE article headed "Television" which appeared in NATURE of Jan. 15, contains the following statement: "a difference of phase of only one degree is capable of spoiling definition." Were this statement true, my television system, depending as it does on synchronism, would certainly, as the writer states, be faced with a very serious barrier. It is, however, a misstatement of fact. Phase difference between receiver and transmitter has no effect whatever upon definition, the whole effect being a displacement of the image as a whole.

Later in the article a statement is made: "The recent claims to have transmitted 'outlines' by infra-red rays mark no advance toward television with diffusely reflected light." This is an erroneous statement. I have on no occasion made claims to have transmitted 'outlines' by infra-red rays. What I have actually demonstrated is the transmission of real images of living faces in complete darkness, using diffusely reflected infra-red rays.

An open invitation was extended to members of the Royal Institution to witness these results, and on Dec. 30, 1926, some forty members of the Institution were given demonstrations at our laboratories. Among those who have witnessed demonstrations I may mention Dr. Russell, Mr. R. W. Paul, and Mr. Creed, who are, I think, sufficiently well known in the scientific and engineering world. In these demonstrations one party remained in a totally dark room; the second party, in a different, were then shown the faces of any of the first party who cared to sit in front of the transmitting apparatus in the dark room.

My discourse at the exhibition of the Physical Society is criticised and the statement made that it was "not the way to convince a sympathetic audience of experts." I was requested by Dr. Rankine, the secretary of the Society, to deliver a lecture suitable for a public audience interested in scientific matters generally, but not experts on television. The lecture was therefore of a semi-popular type and in no way intended for an "audience of experts."

While the writer of the article in Nature appears to be dissatisfied, judging by the reception which the lecture was given and the appreciative letters which I have received, I am assured that opinion was not shared by the bulk of the audience.

I am further criticised for withholding technical details. The writer of the article is surely aware that my inventions are the property of a limited company. The disclosures by me of technical details likely to assist competing interests would therefore be a grave breach of trust to the shareholders. I may further add that we have demonstrated the invention to Government experts, and have received a letter from the Government requesting us to withhold publication of technical details.

The writer states further that: "There are at least three pioneers in the field who appear to be on the verge of a complete solution of the television problem," and mentioned Belin, Jenkins, and Alexanderson. The results which, according to press reports, they have demonstrated should be mentioned. Belin and Jenkins have succeeded in transmitting crude shadowgraphs; and Alexanderson, within the last few weeks, apparently claims to have achieved the same feat. This is a long way from television, and does not justify the statement that they appear to be on the verge of a complete solution of the television problem.

John L. Baird.

Television Limited, Motograph House,
Upper St. Martin's Lane, London, W.C.2,
Jan. 19.

The further information given above by Mr. Baird is precisely the kind which physicists were waiting for. In the absence of a clear description in technical language, many misconceptions are bound to arise, and it would be well for Mr. Baird to consider the advisability of making such a communication at the earliest opportunity consistent with his other obligations.—Editor, Nature.

The Auroral Green Line 5577.

Messrs. McLennan, McLeod and McQuarrie have published in Nature, vol. 118, page 441 (Sept. 25, 1926) the results of some recent experiments on the origin of the auroral green line 5577. During July and August last, while a guest of the Nela Park Research Laboratory, at the kind invitation of Dr. W. E. Forsythe, I had the opportunity of investigating spectroscopically the electrical discharge in mixtures of (1) helium with oxygen, and (2) argon with oxygen. The relative proportions of the two gases in each mixture were varied as well as the current through the gases. In the case of helium with oxygen, traces of this green line were found on some plates, but its intensity was usually very feeble. In one experiment, however, with argon and oxygen, the line 5577 appeared very strongly, about one-half the intensity of the argon line 5559, the iron arc spectrum being used for comparison (Fig. 1. I am indebted to Prof. Lloyd for the enlargement).

The discharge tube was made of pyrex tubing 8 mm. in internal diameter, and was fitted with tungsten electrodes which had been 'outgassed' before introducing the mixture of argon and oxygen (argon pressure = 40 mm., oxygen pressure = 8 mm.). The tube was of H-form, and the discharge was viewed along the bar of the H with a Hilger quartz spectrograph of the D type. The current used was 80 milliamp./cm.^{2}, and the potential 800 volts.

When the tube had run for one and a half hours, a second photograph was taken on which the line 5577

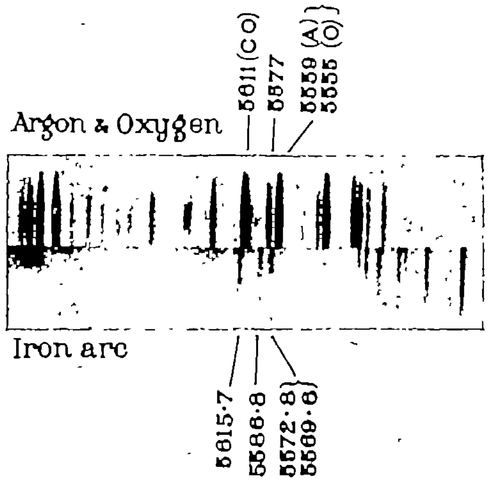

Fig. 1.

was entirely absent. The oxygen had combined with the tungsten, forming a bluish deposit of tungsten oxide on the glass near the electrodes. This result confirms the recent work of McLennan and his co-workers, and the absence of the line when the oxygen was removed is further evidence that the line is primarily due to the oxygen.

David A. Keys.

McGill University.
Montreal.

The Polishing of Surfaces.

Mr. Macaulay and Mr. Preston, in their letters in Nature of Sept. 4, 1926, and Jan. 1, 1927, raise the interesting question of the mechanism by which the surface layer is produced in the process of polishing. This layer, so thoroughly studied by Beilby, resembles a supercooled liquid so nearly that it has been suggested that the surface layers are liquefied.

It does not seem necessary to suppose that actual liquefaction occurs. An amorphous layer indistinguishable from a supercooled liquid will be formed by any mechanism which rearranges the surface molecules at random. The polisher adheres to the surface, and especially with the high coefficient of friction mentioned by Mr. Preston, will tear away the surface particles of the glass when it is moved. Hardy found the surface of solids to be torn by the mere motion of a slider. Some of these particles will naturally be redeposited elsewhere at random, thus forming the amorphous layer. Some of the particles torn away must be of molecular dimensions for the final result to be a completely amorphous layer.

Surface tension in the ordinary sense does not enter into the problem, but since the flat, liquid-like surface is that of least potential energy possible in the circumstances, molecules are more likely to be deposited as part of such a surface, and less likely to be removed from it, than otherwise. The crystalline state, of still less potential energy, will not be formed, as sufficient time is not allowed in the redeposition of particles. This mechanism is actually more likely to produce a completely amorphous layer than liquefaction, for the resolidification of a liquefied surface layer might result in the formation of small crystals.

In his article on 'Polish,' the late Lord Rayleigh concluded that the material is worn away 'almost molecularly.' Some redeposition seems necessary in order to account for the amorphous layer. Probably the polishing, as distinct from an abrading agent, tends to remove particles of molecular dimensions; and the yielding nature of the support frequently used assists the molecules or atoms adhering to the polisher to come frequently into close contact with the glass or metal, and thus promotes redeposition.

N. K. Adam.

University of Sheffield,
Jan. 8.

Fine Structure of the Balmer Lines of Hydrogen.

Using two optical trains, (1) two crossed Lummer plates, the larger of resolving power 670,000, and (2) an echelon of resolving power 660,000, with a vacuum tube of the Wood form having a 1 cm. diameter capillary, cooled with liquid air, we have determined the wave-length differences between the two well-known components λ' and λ'' of H_α, H_β, and H_γ ($\lambda' < \lambda''$), and have sought to obtain still further resolution. The doublet separations are shown in the subjoined table together with those given by Houston (*Astrophys. Jour.*, 64, 2, 1926, pp. 81-92), which latter are, in our estimation, the most trustworthy thus far obtained.

Our values are somewhat higher, but this possibly is not to be wondered at, because of the different current densities employed, 250 against 25 milliamperes per sq. cm. A very trustworthy Lummer plate spectrogram, taken at 13 milliamperes per sq. cm., yields 0·1391 for H_α, which is in harmony with such a current change.

The search for other components revealed a third on the longer wave-length side of λ'. This component is not fully resolved but is clearly present. Moreover, λ'' is distinctly narrower than λ', and under the discharge conditions employed is somewhat more intense. λ' of H_β also shows an asymmetry of the same nature but about one-half as great. Hansen (*Ann. der Physik*, 78-6, 22, pp. 558-600, 1925) has noticed asymmetries in both these cases.

$\Delta\lambda$ in Tenth-Metres.

Line	Houston. (250 ma./sq. cm.)	Kent, Taylor, and Pearson. (25 ma./sq. cm.)	(13 ma./sq. cm.)
H_α	0·1358	0·1370	0·1391
H_β	0·0782	0·0791	..
H_γ	0·0665	0·0669	..

Details will be published in the *Proceedings of the American Academy of Arts and Sciences*, or elsewhere.

Norton A. Kent.
Lucien B. Taylor.
Hazel Pearson.

Boston University,
Boston, Mass., Nov. 19.

Ionisation Phenomena in Active Nitrogen.

In some recent experiments with active nitrogen, it has been found that ionisation effects differ with the gases mixed with the nitrogen. When the active nitrogen alone was drawn past an ion trap into cylindrical condensers, the negative charges obtained were found to be proportional to the areas of the negative electrodes, indicating that the conductivity is due to photo-electrons emitted from the electrode and not to the production of free ions in the gas. The same observations were made when hydrogen and mercury were added to the active nitrogen before it entered the condenser. With iodine (ionisation potential 9·4 volts), however, a different ratio of currents was obtained, showing that ionisation is produced in the gas. This suggests that the phenomena associated with active nitrogen may be due to a metastable state of the nitrogen molecule with energy between 9·4 volts and 10·4 volts. The effect of various gases on the deviation of the after-glow was examined, the most important result being that it is not affected by helium when the helium is made ten times the density of nitrogen.

Ph. A. Constantinides.

Ryerson Laboratory,
University of Chicago,
Dec. 17.

It may be remarked that I showed long ago that the ionisation associated with the decay of active nitrogen was dependent on the gases mixed with it (*Proc. Roy. Soc.*, vol. 86, pp. 60, 61, 184, 1911–12). In particular, sodium vapour greatly increased the effect obtained with nitrogen alone, and oxygen or nitric oxide greatly diminished it. Mercury had little effect, as in the experience of Mr. Constantinides. The views expressed by him scarcely seem adequate to cover all the above facts. But the subject is doubtless well worth pursuing, with the much greater theoretical illumination of the present time.

Rayleigh.

Jan. 5.

The Problem of Secretion.

The summary of Bowen's recent discussion of the cytology of secretion in Nature of Jan. 1, p. 30, fails to do justice (as Bowen himself has done in his papers) to the contribution of other workers to this difficult subject.

The earlier work of Golgi, D'Agata, Cajal, and Da Fano, and the investigations of Bowen's immediate predecessors and contemporaries, Nassonov, Brambell, Ludford, and Cramer, contribute so materially to the establishment of our present state of knowledge, that the impression conveyed by the summary in Nature that this work is solely the achievement of Bowen is, we feel, unfair to the other investigators mentioned. As representing the institutes in which much of the work in Great Britain has been carried out, we think that this article should not be allowed to pass without comment.

Jas. P. Hill.
J. A. Murray.

Department of Histology and Embryology,
University College,
Imperial Cancer Research Fund,
Jan. 4.

Most of the short notice referred to was prepared as paragraphs for "Research Items," which accordingly were intended to be simply a summary of the position of the problem as presented by the author. The paragraphs were afterwards arranged, with little modification, in the form of a short notice. This was offered as a brief statement, not for the specialist but for the more general reader, of the present position as set forth in one of the latest accounts of the subject; it was not intended to be a review of the literature of the problem. Such a review, which would need to be much more extensive, would, of course, take full cognisance of the previous investigations referred to in the above letter.—Editor, Nature.

Popular Long-Range Weather Forecasts.

THE 50-day weather forecasts published in the *Daily Mail* have attained such popularity that an authoritative pronouncement from science as to whether they have or have not any real value has become desirable, and Capt. Cave is to be congratulated on opening an investigation on the subject.

The principles on which the curves are prepared are largely empirical, so that it is only by long-continued comparison of expectations with facts that their dependability can be estimated or improvement can be effected. Their preparation entails a large amount of labour and involves the maintenance of an office with technical assistance. They have never received the support of official meteorology, so that, without the public-spirited enterprise first of the *Field* and now of the *Daily Mail*, the work could not have been carried on. From the point of view of science, two consequences of this are unfortunate:

(1) The form in which they appear is popular rather than scientific.

(2) It has not been possible to publish full details of the methods used without disloyalty to those who have backed them.

Before trying to compare the expectation diagrams with facts, it is necessary to be quite clear as to what is aimed at in them. Since they are published for popular use and not for scientific study, the explanation given with them is not so complete as a scientist might wish. It is stated that—

(1) Nothing approaching infallibility is claimed.

(2) The diagrams indicate the expectation of rain; the higher the curve the greater the expectation.

(3) The curves are not intended as day-to-day forecasts, and their author is quite satisfied if the timing of his expectations is correct within 24 hours either way.

This was explained in some detail, but in popular form, in the *Daily Mail* of April 30, 1926.

For the benefit of more scientific readers their author would like to add:

(4) The datum line and the shaded and blacked areas are intended only as a guide to the eye and have no precise significance.

(5) While the curves primarily indicate degree of expectation, it is reasonable that they should also show some relation to rain amounts. At one time the investigations were based on rain or no-rain, 50 mm. being counted as exactly the same as 0·2 mm., but now (as from June 17, 1926) the factor of amounts has been introduced into the expectations, and their author aims at checking his results for each station by plotting the actual rain amounts to the vertical scale shown in the following table, which is roughly proportional to the logarithms of the amounts. It will be realised that this is an extremely searching test, and one which even 12-hour forecasts would not be able to stand.

(6) The diagrams for the British Isles as a whole show the extent to which rain is expected to be general over the British Isles.

Rain Amount	Vertical Scale.
Nil	− 2 units
Up to 0·1 mm.	− 1 ,,
,, 1·0 ,,	0 ,,
,, 2·0 ,,	+ 1 ,,
,, 5·0 ,,	+ 2 ,,
,, 11·0 ,,	+ 3 ,,
,, 25·0 ,,	+ 4 ,,
,, 56·0 ,,	+ 5 ,,

It is to be regretted that Capt. Cave did not study the *Daily Mail* of April 30, 1926, or communicate with the author of the diagrams before making his tests, for it will be seen that neither his "weather numbers" nor his "forecast numbers" are appropriate. Both his criticism and his diagrams, therefore, being based on those numbers, fail to apply.

Further, since the complete set of curves is made for the 50 days independently every week, each one has a character of its own, and should be considered as a whole. To select the fourth to the tenth days out of each 50 for criticism is like criticising a 12-hour forecast by examining the weather for an interval of 103 minutes out of each day. For this reason, too, the comparison made in Capt. Cave's diagrams is not a fair one.

The *Daily Mail* curves are based on the combination of fifteen cycles which are selected for each of the four stations every week. Some of these cycles are well known, and no originality is claimed for them; others have been developed for this special purpose, and have stood the test of time; others again are still in the experimental stage. The method of selecting the cycles depends partly on permanent factors, which can be anticipated for any length of time ahead, and partly on temporary factors, which may change from time to time. While, therefore, some of the cycles usually remain the same from week to week, often changing conditions introduce new ones, causing more or less variations in the expectation curves. Such variations do not seem unscientific or in any way unreasonable. They must be admissible even in a 12-hour forecast—if a forecaster at 8 A.M. expects a heavy shower at 2 P.M. and at noon modifies his forecast and expects a moderate shower at 3 P.M. instead, we do not regard him as a fraud or his forecasts as worthless. Whether or not the diagrams under discussion are invalidated by the modification is a question of degree which can only be decided by a careful comparison of a series of complete diagrams over a long period.

For this purpose two sets of diagrams are here shown. Fig. 1 is a series of ten expectation curves as published in the *Daily Mail* for the British Isles as a whole, covering the period June 18–Oct. 7, 1926. This series is a fair average sample, and it shows the extent of the weekly variation in the curves for the British Isles; at individual rain gauges obviously somewhat greater variation must be expected. As a convenient check on the results, a curve of facts has been added in which the ordinates are made proportional to the number of rain gauges, out of the 43 British reporting stations, which have recorded rain (0·2 mm. or more) during the 24 hours.

Fig. 2 is a series of five expectation curves for the Scilly Isles, covering the period July 2 – Sept. 16, 1926, together with a curve of facts plotted according to the logarithmic scale explained above. This series is selected from among those which Capt. Cave criticised, and is perhaps above the present average of achievement.

Such a juxtaposition of a series of expectations with facts seems to be the only fair and conclusive method of testing them; but it will be seen that the method is a severe one, and it will perhaps be agreed that, if any series of 12-hour forecasts were graphed in the same way and checked for every quarter hour, they would probably not compare with facts nearly so well as these do.

The diagrams for the Scilly Isles were also tested on the basis of day-to-day expectations checked with rain or no-rain facts, and the degree of success attained was compared mathematic-

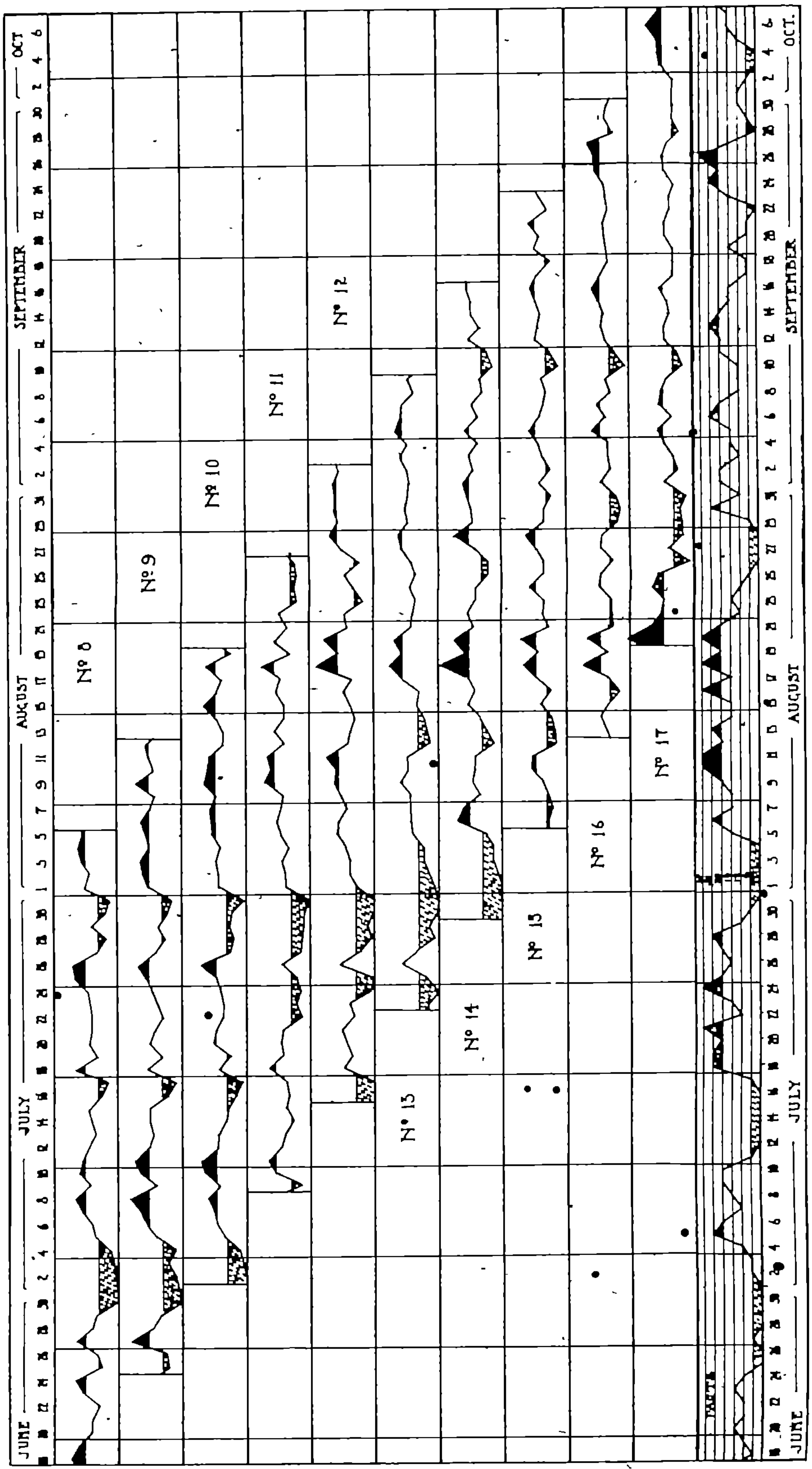

Fig. 1.—Great Britain and Ireland. Comparison of *Daily Mail* charts with observations of ten diagrams for 1926.

ally with what might be expected of a random guesser.

The data were obtained as follows: In each published curve, each day which was shown blacked was regarded as a rain expectation; if 0·2 mm. or more of rain was officially recorded that day, it was considered a success; if less than 0·2 mm. of rain, a failure. Similarly, each day which was shown shaded was regarded as a no-rain expectation; if less than 0·2 mm. of rain was officially recorded that day, it was considered a success; if 0·2 mm. or more, a failure.

In the diagrams for the Scilly Isles shown in Fig. 2, the rain expectations have been marked with an arrow pointed upwards, the no-rain expectations with an arrow pointed downwards. It should be mentioned that the published diagrams always begin on a Friday, but, since they are completed and leave their author's hands on the Wednesday, for the purpose of his own checking he always includes the Thursday's expectation, which is not published, and it has been done for the purpose of this check too. This is slightly to his advantage, for 12 definite expectations for the first Thursday are included in the series here considered, and of these 8 were successes and 4 were failures.

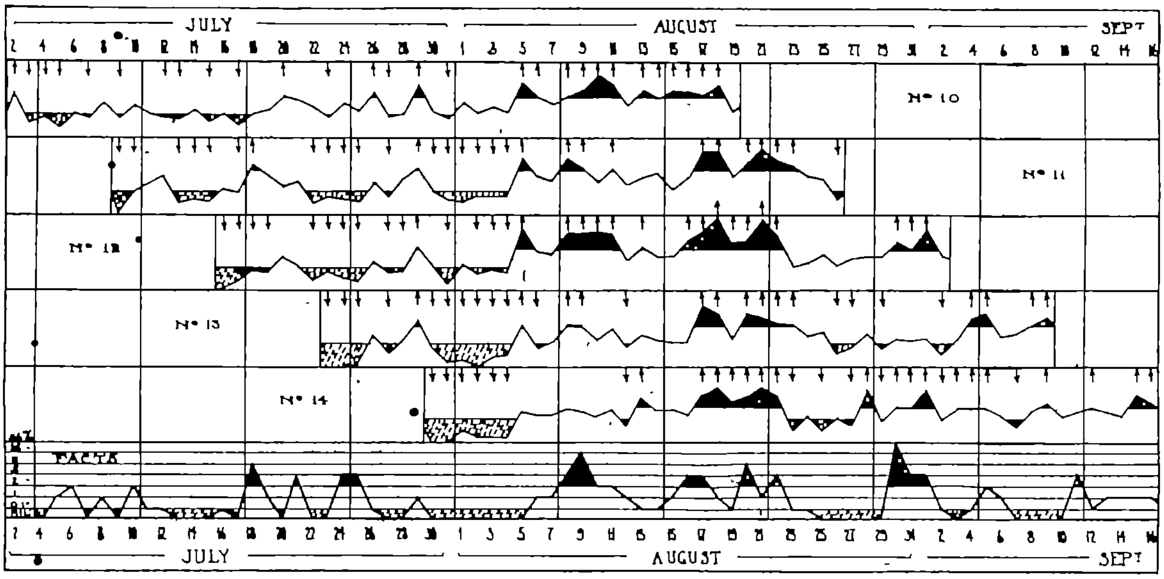

FIG. 2.—Scilly Isles. Comparison of expectations with observations, 1926

Over the period June 17–Dec. 3, 1926, for the Scilly Isles 640 definite expectations were made. Of these, 412 were successes and 228 were failures on the day-to-day basis explained above. At first sight this may not seem a very striking measure of success, and for a small number (say 12 expectations) such a proportion could reasonably be attributed to chance; but for 640 expectations, the odds against a random guesser making 412 successes are incredibly large. If any one doubts it, let him try spinning a coin 640 times, and he will find that he never gets anything approaching 412 of either heads or tails.

The odds against the random guesser were tested according to the theory of probability. Given that the facts for the days considered were 348 rain and 292 no-rain, also that the guesser makes 640 guesses, knowing that the normals for the period are 95 rain and 74 no-rain, so that he would guess rain 360 times and no-rain 280 times.

Assuming the above data only:

The chance that the guesser would get exactly 412 successes is

$$\frac{\underline{|348} \times \underline{|292} \times \underline{|360} \times \underline{|280}}{\underline{|240} \times \underline{|108} \times \underline{|120} \times \underline{|172} \times \underline{|640}} = 7{\cdot}00 \times 10^{-13}.$$

By adding the chances of more than 412 successes we get $1{\cdot}01 \times 10^{-12}$.

The odds are therefore $9{\cdot}90 \times 10^{11}$ to 1 against a random guesser scoring 412 or more successes under the conditions assumed.

These calculations were made by Mr. W. Hope-Jones, of Eton College, and confirmed by Dr. R. A. Fisher, of Rothamsted Experimental Station.

Admittedly there may be factors which perhaps ought to be included, and might, if included, reduce this figure, but it would appear that, in whatever way the problem may be tackled, the odds against a random guesser doing so well are practically infinite.

The expectations and facts may be tabulated as follows:

	Expectations.		
	Rain	No Rain	Total.
Rain Facts . .	243	105	348
No-Rain Facts .	123	169	292
Total	366	274	640

It has been the purpose of this article to show that—

A. Owing to the popular form in which these expectations are produced, Capt. Cave formed an erroneous conception of their aims, so that his arguments were unsound and his conclusions misleading.

B. A careful examination of a series of diagrams indicates that

(1) Variations from week to week are not great, and generally tend towards improvement as time advances.
(2) Although it is not claimed that rain amounts are correctly anticipated, the peaks and dips of the expectation curves correspond with those of the facts curve in many cases to the actual day, and in most cases to within 24 hours.
(3) There is a degree of correspondence between expectations and facts which cannot be wholly due to chance.

C. The above is confirmed definitely and conclusively by the calculations based on the theory of probability.

If these propositions are accepted, and it would seem hard to dispute them, then it must be agreed that the claims made in the *Daily Mail* are more than substantiated, and that what Capt. Cave condemns as no better than fortuitous prediction has been proved to be something of the order of a billion times better, and represents in fact a notable advance in meteorological science.

R. P. BUTLER.

CAPT. BUTLER complains that my weather and forecast numbers are unfair, and appeals to the *Daily Mail* for April 30. The only relevant sentence seems to be that the greater the height of the curve above the datum line the greater the probability of rain, but not necessarily the amount of rain; I do not think that this fact invalidates anything I have said. I have already explained the method of comparing the forecast diagrams with the weather, and I am quite content to leave it to the readers of NATURE to say whether the method is fair or unfair.

It is also said that the forecasts are not meant to be day-to-day forecasts; they are, however, given in a day-to-day form, and are, I think, generally so taken by the public; Capt. Butler, however, emphasises the point and says that the author is quite satisfied if the timing of his expectations is correct within twenty-four hours either way. The number of wet days with 0·04 inch of rain or more is about 120 in the year for the south-east of England, or one day in every three; any one forecasting rain for to-day and claiming a success if rain comes yesterday, to-day, or to-morrow, is putting his forecast in a very favourable position. If one were to forecast by drawing counters out of a bag, the successes under the above conditions would be very marked.

I do not understand Capt. Butler's complaint that I only took one forecast for each week for the purpose of comparing them with the weather in my diagrams. I took the complete week nearest to the actual happenings as being the most fair to the author. Capt. Butler says that each 50-day forecast has a character of its own, which is exactly what I maintained. I have selected one of the seven varying forecasts for each week and compared it with the actual weather, and I have done this for the whole period from April 15 to Oct. 27. To say, as Capt. Butler does, that doing this is like "criticising a 12-hour forecast by examining the weather of 103 minutes out of each day," seems to me to be a statement devoid of meaning. If the forecasts are in the main similar, there is nothing unfair in taking any one in preference to the six other forecasts for the same week; if they differ, it is reasonable to suppose that the one nearest to the period for which the forecast is made would be the most correct; I therefore took the first complete week of the latest forecast. Capt. Butler's diagrams show exactly what I maintained, that the forecasts for each week vary so materially as they are issued week by week that they cannot all be guides to the coming weather. Nor are his diagrams of facts compared with forecasts very striking. I pointed out that August was a particularly favourable month for the forecasts, especially in south-west England; I do not see anything very remarkable in the diagrams as extended to July and September.

The method of the forecasting is still wrapt in obscurity on the plea that to disclose the method would be an act of disloyalty to those who have backed the forecasts. Such an attitude to scientific truth has probably never before made its appearance in the pages of NATURE. It precludes one from examining the worth of the forecasts except in so far as the results declare it, and nothing that Capt. Butler has brought forward changes my opinion that chance operates largely, if not entirely, in the relation of forecasts to facts. His probability figures do not impress me very much. He has evidently treated each of the seven weekly forecasts as entirely independent, which he himself claims not to be the case. If they were not treated as independent variables, I fancy that the impressive figures he brings forward would dwindle to very modest proportions. In any case he has attempted to prove too much; if the forecasts are a billion times better than would be expected on pure chance, failures should practically never occur, whereas it is obvious, even from his own selected diagrams, that the method cannot be relied on by the farmer for his agricultural operations, or by the man in the street who wants to know whether or not to take out his umbrella.

C. J. P. CAVE.

Obituary.

GENERAL SIR CHARLES WARREN, K.C.B., G.C.M.G., F.R.S.

GENERAL SIR CHARLES WARREN, the distinguished soldier and archæologist, died on Jan. 21, in his eighty-seventh year. Born on Feb. 7, 1840, he was educated at Cheltenham College, Sandhurst, and Woolwich, passing into the Royal Engineers in 1857. He had a distinguished career both as technical officer and as a military commander in South Africa and Egypt. He commanded a column in the Boer War, and was afterwards in command of the troops at the Straits Settlements.

Like his fellow-soldiers, Gordon, Kitchener, Watson, and Wilson, Warren was greatly interested in research in Palestine. This brought him into touch with the founders of the Palestine Exploration Fund, and from 1867 until 1870 he conducted excavations at Jerusalem and made a reconnaissance of Palestine on behalf of that Society. Notwithstanding much opposition on the part of the local authorities and the difficulty of raising funds, he accomplished valuable work. This bore fruit in a number of publications. He was author of part of "The Recovery of Jerusalem: Underground Jerusalem," 1876, "The Temple and the Tomb," 1880, and the Jerusalem volume of the Survey of Palestine, with a portfolio of plates and excavations (1884). He had also devoted much attention to the question of ancient standards of measurement, and published "The Ancient Cubit and Weights and Measures" in 1903, and "The Early Weights and Measures of Mankind" in 1914. His connexion with the Palestine Exploration Fund continued throughout his life and he was for some years a member of the committee. This association had brought him closely into touch with Sir Walter Besant, secretary of the Fund. With him he founded the Quatuor Coronati Lodge of Freemasons, the object of which was masonic research, and Warren became its first Master.

WE regret to announce the following deaths:

Mr. W. M. Chauvenet, consulting chemist and mining engineer, who worked at the chemistry of ores and at structural and mining geology, aged seventy-one years.

Dr. Karl Hell, emeritus professor of general chemistry at the Technische Hochschule in Stuttgart, who died on Dec. 11, aged seventy-seven years. He was the author of numerous publications in organic chemistry.

Dr. Herbert A. Howe, dean of the college of liberal arts at the University of Denver and director of the Chamberlin Observatory at the University, who was known for his work on the positions of nebulæ and on comets and asteroids, aged sixty-eight years.

Mr. Daniel Irving, president in 1904 of the Institution of Gas Engineers, and chief engineer for many years of the Bristol Gas Company, on Jan. 12, aged seventy-one years.

Mr. John Webster, senior scientific analyst to the Home Office, who had published several papers on arsenical poisoning and on the toxicology of salvarsan, on Jan. 20, aged forty-nine years.

News and Views.

BEFORE publishing in NATURE of Jan. 8 the article by Capt. C. J. P. Cave on "Popular Long-Range Weather Forecasts," we sent an advance proof to Lord Dunboyne, whose fifty-day forecasts are published in the *Daily Mail* and formerly appeared in the *Field*. Lord Dunboyne desired to reply to the article but found himself unable to do so, and he therefore entrusted his case to his brother, Capt. the Hon. R. P. Butler, whose article appears elsewhere in this issue, together with Capt. Cave's comments upon it. Having now devoted a fair amount of our congested space to the subject we think no more can reasonably be expected, and our readers may safely be left to form their own conclusions upon the evidence which has been placed before them. We are, of course, glad to give Lord Dunboyne credit for a desire to discover principles by which long-range weather forecasts may be secured, and we should be sorry to discourage him or any one else working to achieve this aim. We must point out, however, that the appropriate place to present such principles is a scientific society, like the Royal Meteorological Society, where they would be discussed by people best able to express a judgment upon them. It is of no use to say, as Sir Theodore Cook, the editor of the *Field*, does, in a letter to us, that while Lord Dunboyne contributed the forecasts to the columns of that journal he received "the most satisfactory letters from farmers and correspondents of every kind in all parts of England." Science is not concerned with belief when processes of Nature are involved, but with evidence; and no principle or theory ought to be recognised in scientific fields unless it can survive critical discussion. When Lord Dunboyne's methods and results are submitted to such a bar of competent opinion, we shall be glad to render a further account of them.

OUR leading article of Sept. 4, 1926, on Prof. Graham Kerr's presidential address to Section D (Zoology) of the British Association at Oxford, has moved Mr. George H. Bonner to return to the subject of the advantages of a classical education in the *Nineteenth Century* for January. The author excuses himself for attempting to revive "so hoary a subject" on the ground that the question of the rival merits of 'classical' and 'scientific' is among the most vital that can be propounded, and that when the subject is thoroughly analysed it may appear that only the fringe has been touched and the real reasons for a preference overlooked. Education, as Mr. Bonner conceives it, is to confront the mind with truth in such a manner that it is immediately recognised and becomes a conscious possession. Broadly speaking, the line of argument taken is that science being confined to observed facts and 'laws,' which are merely theories subject to change with the advance of knowledge, does not deal with truth in the sense of the apprehension of 'purpose' and the ultimate realities of the universe and God—the essential element in the training of the higher faculties of man and the development of the power of reasoning.

MR. BONNER goes on to point out that even the 'practical' advantage, usually urged in favour of science, really lies with the classics, which induce an acquaintance with a wide variety of topics and a flexibility and adaptability of mind not to be acquired by a study of facts and the 'laws' of science. In this connexion it is of interest to refer to the closely parallel argument in favour of university education generally in a recent letter to the *Times* in reply to a criticism of the capabilities of university men in business, where it was pointed out that during the War it was pre-eminently a university training which produced the qualities of flexibility, adaptability, and ready accommodation to individuals and circumstance, requisite in the officer trained under stress of emergency. Whether or not we are prepared to follow Mr. Bonner in attributing the individual qualities of Greek literature to the influence of Egypt, it will be allowed that he takes up a strong position when he holds in relation to his main line of argument that the classics form collectively an expression of truth more complete than any literature in the world, enabling man "to see things as they are and not as they seem to be." Mr. Bonner, however, misunderstands our article if he imagines that we discount the value of the teaching of science. To point out where the discipline has failed is not to condemn it but rather to help it to achieve those results which, as a unit in a properly balanced system of education, we know it can produce.

THE Geological Society of London has recently announced the following awards: The Wollaston medal to Prof. W. W. Watts, who has distinguished himself by his work on the ancient rocks of the Charnwood Forest, the igneous rocks of the Midlands, and the stratigraphy of the Welsh border, especially Shropshire. The Murchison medal to Dr. G. T. Prior, Keeper of the Department of Mineralogy in the British Museum (Natural History), who is distinguished especially for his work on the chemical composition of meteorites. The Lyell medal to Sir Albert Ernest Kitson, Director of the Geological Survey of the Gold Coast, where he has distinguished himself by the discovery of manganese, bauxite (aluminium hydrate), and diamonds. The manganese proved to be of considerable importance, especially during the War. The Bigsby medal to Dr. Bernard C. Smith, of the Geological Survey, who has done good work in the Midlands, Cumberland, and north Wales, including some interesting researches on the former courses of rivers and on ancient swallow holes. The Wollaston Fund to Miss M. E. J. Chandler, who, both in conjunction with Mrs. Clement Reid and independently, has made considerable additions to our knowledge of Tertiary and Pleistocene plants by the separation and examination of seeds in sediments. The Murchison Fund to Dr. S. H. Haughton of the Geological Survey of South Africa, for his work on fossil vertebrates. One-half of the Lyell Fund to Dr. Leonard Hawkes, reader in geology at Bedford College, London, for his researches in petrology, especially on the igneous rocks of Iceland. The other half of the Lyell Fund to Miss Edith Goodyear, senior assistant in the Geological Department of University College, London, for her work on the stratigraphy and palæontology of the Carboniferous rocks.

DURING recent years city and suburban traffic has increased so rapidly that it is very difficult to provide transport facilities for it. The competition also between motor omnibuses and electric tramways has become very acute. The latter especially have been forced to improve the facilities they offer. In particular they run at higher speeds. Recent specifications for tramcar equipment demand a running speed of 25 to 30 miles an hour, which is practically double that demanded before the War. The length of the cars has greatly increased, and so also has their seating capacity. It is therefore necessary to use larger electric motors. It is usual to specify for two motors for each car, each being rated at from 50 to 60 horse-power. In pre-War tramway motors the armatures used to run at 600 revolutions per minute, whereas they now run at 900 revolutions per minute; also instead of being totally enclosed they are now self-ventilated. One important result of these changes is that the motors are both smaller and lighter, although they can exert nearly double the power. The design of tramway controllers has also been greatly improved, the large currents being broken by a powerful magnetic 'blow-out.' These controllers are used by the London County Council, and at Edinburgh, Manchester, Glasgow, and Newcastle-on-Tyne.

THE annual general meeting of the Royal Meteorological Society was held on Wednesday, Jan. 19, and Sir Gilbert Walker was re-elected president. The Buchan Prize, which is awarded biennially for the most important original papers contributed to the Society during the previous four years, was presented to Mr. C. K. M. Douglas. Sir Gilbert Walker delivered an address on "The Atlantic Ocean," in the course of which he directed attention to the value, when studying the movements of the atmosphere, of an understanding of oceanic circulations. He described the conditions of temperature, salinity, and density revealed by recent measurements in the Atlantic down to a depth of 10,000 feet or more. These throw light on the general character of the oceanic circulation, and indicate that though prevailing winds may set up surface currents, they probably produce no significant effect at a depth exceeding 700 feet. Icy water from the Arctic, and especially the Antarctic, flows towards and even beyond the equator at great depths, and as the air temperature is largely controlled by that of the sea, variations in the general circulation may provide the explanation of some of the big seasonal changes which occur in equatorial as well as in temperate regions.

PROF. A. S. EDDINGTON, Gifford Lecturer for 1927, who has chosen for the subject of his course "The Nature of the Physical World," gave the first of ten lectures at the University of Edinburgh on Friday, Jan. 21, on "The Failure of Classical Physics." The Earl of Balfour, Chancellor of the University, presided. Prof. Eddington said that in these lectures he proposed to explain some of the results of the modern study of the physical world which give most food for philosophic thought, and to show how we have been led to think of the material universe in a way very different from that prevailing at the end of the last century. He would not leave out of sight the ulterior object which must be in the mind of a Gifford Lecturer—the problem of relating these purely physical discoveries to the wider aspects and interests of the human soul. These relations cannot but have changed since our whole conception of the physical world has radically changed. He is convinced that a just appreciation of the physical world as it is conceived to-day carries with it a feeling of open-mindedness towards deeper significances behind it, which may have seemed illogical a generation ago; near the end of the course he would try to focus that feeling and make inexpert efforts to find where it leads. Prof. Eddington then proceeded to a consideration of some of the revolutionary changes in our views of space and matter resulting from the new theory of matter originated by Rutherford, and from Einstein's theory of relativity. Further lectures of the course will deal with time as a fourth dimension, the running-down of the universe, gravitation, the quantum theory, the nature of the stars, inorganic evolution, world building, the domain of physical science, and science and mysticism.

DR. R. CAMPBELL THOMPSON, in a lecture on Jan. 18 at Bedford College for Women (University of London) on "Conceptions of the Cosmos in Ancient Babylonia," pointed out that it is impossible to deal with the subject from any but a theological point of view. The early Babylonian ideas, like those of all early peoples of whom we have knowledge, were influenced by their view of the supernatural and by their geographic environment. The beliefs of the early Sumerian inhabitants of Babylonia appear to have been adopted by their Semitic successors without much change. After an introductory sketch of their mythological system between the approximate dates of 5000 B.C. and 2000 B.C., in the course of which he pointed out the traces of Babylonian influence in the New Testament, Dr. Campbell Thompson described, with the aid of a diagram, the cosmos as conceived by the Sumerian and Semitic inhabitants of the land. The earth, which was of course limited to the land of which they had knowledge, was surrounded by the ocean, which was again encircled by an enclosing dam. The three heavens above, with the lower earth and Hades beneath, comprised the universe. The sun god emerging from the mountains of sunrise in the east ran his course across the firmament and entered the earth again by the mountains of sunset in the west. A pastoral people inhabiting a flat land naturally had their attention turned to the sky and its heavenly bodies, and looked to them for omens. In the Babylonian cuneiform script, the sign for a god is the same as that for a star. Astronomical science, however, as opposed to astrology, developed at an early date. The Babylonian astronomers had sufficient knowledge to predict eclipses with some accuracy, though not the point from which they would be visible. Dr. Campbell Thompson illustrated his remarks by references to the creation and other myths preserved on the clay tablets which formed the libraries, and showed many beautiful slides both of the scripts and drawings. At the end of the lecture he delighted his audience by reading translated extracts from the Gilgamesh Epic on which he is at present at work.

SIR WILLIAM BRAGG'S discourse at the Royal Institution, delivered on Jan. 21, dealt with "Tyndall's Experiments on Magne-crystallic Action." In 1845, at the Royal Institution, Faraday made a great step forwards in the science of magnetism. He constructed a powerful electro-magnet; the core was formed from a link of a large chain cable and the heavy copper wire was wound for the occasion, because covered wire was not an article of commerce in those days. With this he showed that practically all substances have magnetic properties, and remarkable relations were found to exist between magnetic properties and crystalline structure. These results led to his conception of 'lines of magnetic force.' These lines he imagined to run not only through material substances when magnetised, but also through the space about a magnet; so that in his view it was possible to speak of the ether of space being magnetised and to measure its consequent energy. These discoveries of 1845 excited great interest and were widely repeated, extended, and discussed. Much work was done by Tyndall, whose results were interpreted by Faraday as supporting his own theories. Tyndall, however, preferred an interpretation, as did others of the same time, which laid much less stress on the part played by the ether and fixed attention on the material bodies concerned. In particular he subjected bodies to great pressure, and showed how their magnetic properties seemed to be changed thereby. The views of Faraday have now been wholly accepted; but all careful work has its value, and even in those days Tyndall was able by his discoveries of the effects of pressure to make a material advance in the geological interpretation of the planes of cleavage in the earth's strata. Quite recently the application of X-ray methods to the study of the crystalline structure of substances makes it possible to offer a more complete explanation of Tyndall's results. The effects of pressure are to rearrange the minute crystals which most ordinary substances contain; and so Tyndall's results form part, not so much of the branch of science for which they were intended, as for that which deals with the effects of stresses of all kinds in altering the internal arrangement and the properties of materials.

MR. E. BRUNETTI recently presented to the Department of Entomology of the British Museum (Natural History) a collection of some 60,000 specimens of Diptera (two-winged flies) especially rich in Indian and North American material. The collection is the result, in part, of the entomological collecting done by Mr. Brunetti during the last forty years. The same Department has also received, under the terms of the will of the late Lieut.-Col. F. R. Winn Sampson, an important collection of insects of the group Scolytidæ (bark-beetles). The collection consists of some 11,000 insects and 1400 microscopic preparations, and the bequest includes a selection of books and pamphlets, and two microscopes. Accessions to the Geological Department include three interesting fossils of flying reptiles: the long-tailed group is represented by a specimen from the Lias of Württemberg; the short-tailed pterodactyls by an excellently preserved wing-skeleton from the Lithographic Stone of Bavaria, and by a slab with several scattered bones of a small form from the Middle Purbeck beds of Swanage. This last was found and presented by Mr. S. L. Wood, who also gave the remains of a turtle carefully pieced together, and some unusually complete jaws and teeth of Anoodon, an ancient cloven-hoofed animal, all collected by him from the Hamstead beds of Yarmouth, Isle of Wight. The Lower Devonian slates of Bundenbach have yielded most interesting fossils beautifully preserved in pyrites. To the valuable series already in the Museum, some new forms of starfishes, crinoids, and trilobites have been added. An important purchase agreed to was a collection of Ammonites, mostly preserved in pyrites, from various openings, now closed, in rocks of Bavaria and Württemberg corresponding to the Kellaways rock of Britain. There was also laid before the trustees a plaster reproduction of the most complete nest of dinosaur eggs found by the American Expedition in Mongolia; this has just been received from the American Museum of Natural History.

THE purchase has been approved for the Department of Minerals of the British Museum (Natural History) of a 9-kilogram mass of meteoric iron from Chile, probably belonging to the La Primitiva fall, remarkable for the large inclusions of the phosphide of iron and nickel, schreibersite; also specimens of twelve meteorites not hitherto represented in the collection; and a cast of the wonderful 688-kilogram ring-shaped meteoric iron of Tucson, Arizona. An interesting book purchased for the Museum Library is the very rare first edition of an account by Linnæus of his scientific expedition through the Swedish province of Skånen in 1749. This edition contained an expression of approval of the burning up of the top-soil, a custom of the inhabitants of Småland, and a practice to which Baron C. Hårleman, the patron of Linnæus, was strongly opposed. Hårleman had paid the expenses of the expedition, and he caused the withdrawal of the first edition of this work and the publication of a second without the offending comment.

MR. W. G. LOBJOIT, Controller of Horticulture at the Ministry of Agriculture, is retiring from that honorary post, and Mr. H. V. Taylor has been appointed Horticultural Commissioner of the Ministry and chairman of the Horticultural Advisory Council.

AT the meeting of the London Mathematical Society, at 5 o'clock on Thursday, Feb. 10, at the Royal Astronomical Society, a lecture entitled "Some Problems of Terrestrial Magnetism" is to be delivered by Prof. S. Chapman. Members of other scientific societies are invited to be present.

AT its meeting in Philadelphia in December last, the Botanical Society of America elected Prof. Harley H. Bartlett, of the University of Michigan, as president, and Prof. Arthur J. Eames, of Cornell University, as secretary. The following were elected corresponding members: Prof. Erwin Baur, of the Agricultural High School, Berlin; Prof. Robert Chodat, of the University of Geneva; Dr. L. Cockayne, of New Zealand; Prof. V. Grégoire, of the University of Louvain; and Prof. W. Johannsen, of the University of Copenhagen.

AT the monthly general meeting of the Zoological Society of London held recently, it was reported that the number of visitors to the Society's Gardens during the past year was 1,937,935, the receipts for admission amounting to £61,325, an increase of £2728 as compared with the figures for 1925. The numbers of visitors to the Aquarium during the past year was 436,327, the receipts for admission amounting to £17,242, an increase of £483 as compared with last year.

THE council of the Institution of Electrical Engineers has made the sixth award of the Faraday Medal to Prof. Elihu Thomson, of Boston, U.S.A., honorary member of the Institution, who is well known as one of the pioneers in the development of electrical engineering. It will be recalled that the Faraday medal is awarded by the council of the Institution not more frequently than once a year either for notable scientific or industrial achievement in electrical engineering or for conspicuous service rendered to the advancement of electrical science, without restriction as regards nationality, country of residence, or membership of the Institution.

DR. THOMAS NELSON records in the *Lancet* for Jan. 1 (p. 16) the after-results of the treatment of ten cases of tuberculosis by Mr. Spahlinger's methods in a London hospital. The cases were selected and treated by the late Dr. Latham about twelve years ago, and comprised one case of lupus, one case of spinal tuberculosis, and eight cases of pulmonary tuberculosis. The spinal case and one of the pulmonary cases cannot now be traced. The lupus case is still alive, but all the remaining seven pulmonary cases are dead—six of them within three years of the commencement of treatment.

A SLIGHT earth tremor was recorded at the Royal Observatory, Edinburgh, between 5.20 A.M. and 5.30 A.M. on Jan. 24. A message from Nairn to the Air Ministry also reported a slight earthquake at about 5.20 A.M., and records of the shock were obtained at Kew and Plymouth. The Kew record indicated a distance of about 500 miles for the centre of disturbance, but the disturbance was of less intensity than the Herefordshire or Jersey shocks of last year. Messages from correspondents of the *Times* in various parts of Scotland state that earth tremors were felt in the Orkneys, Deeside, Perthshire, and Fifeshire.

Notices have been issued of the offer of three Beit Fellowships for Scientific Research in July next. These fellowships are tenable at the Imperial College of Science and Technology, and will probably be awarded for two years. Candidates must be graduates of a university of the British Empire, of European descent, and less than twenty-five years of age. The annual value of each fellowship is £250. Application forms must be returned to the Rector, Imperial College of Science and Technology, South Kensington, London, S.W.7, by April 19 next.

The Government of the Province of Buenos Aires, Argentina, has just distributed vol. 5 of the collected works of the late palæontologist, Florentino Ameghino, dated 1916. The volume consists of papers, chiefly on fossil mammals, published between November 1884 and May 1889, but unfortunately the original place of publication is usually omitted. A general account of the mammal-bearing deposits of Monte Hermoso is reprinted from the Buenos Aires newspaper, *La Nación*, and there is an interesting address on the "Phylogenetic Evolution of Mammals," which was given in 1889 to the Argentine Geographical Institute.

At the first meeting of the eightieth academic year of the Pontifical Academy of the Nuovi Lincei, held in the premises of the Academy in the grounds of the Vatican and attended by his Holiness the Pope, Cardinals Merry del Val, Maffi, Vannutelli, and Ehrle, the two secretaries of the Academy, Profs. De Sanctis and Martinelli, and a number of members and others, the inaugural lecture by the president, Prof. Gianfranceschi, was followed by several papers on scientific subjects. At the conclusion of the session the secretary made preliminary announcements concerning the arrangements for the year and for the commemoration this year of the Volta centenary.

The sixth annual report of the Industrial Fatigue Research Board contains details of the organisation, investigations, and researches for the year ending December 31, 1925, followed by an analysis of the work published by the Board up to date. The various reports issued during the last six years have been analysed and all the evidence relating to a particular problem collected into one section. The first section deals with the scope and methods of investigations, the second with hours of labour in various industries, the third with atmospheric conditions and lighting, the fourth with methods of work, and the fifth with miscellaneous points such as individual differences, learning and practice, human and mechanical factors in production. It is a very useful compilation, and should prove a valuable guide to present-day research in industrial problems.

The trans-Atlantic telephone service to towns outside London and to several of the American States was inaugurated on Saturday, Jan. 22, by the exchange of messages between the vice-chancellor of the University of Cambridge and the president of Harvard University, Cambridge, Mass. Mr. A. L. Lowell, of Harvard, spoke first; the Rev. G. A. Weekes, who replied from the Master's Lodge in Sidney Sussex College, recalled the fact that Harvard received its name from John Harvard, a student of Emmanuel College, Cambridge, nearly three hundred years ago. Sir Ernest Rutherford, and Dr. Peter Giles, Master of Emmanuel, also spoke to Mr. Lowell, while Mr. Moran, president of the Southern Atlantic Telephone Company, spoke from New Haven, Connecticut. The extended service now includes most towns within about 110 miles of London, and on the other side of the Atlantic the States of Maine, New Hampshire, Massachusetts, Vermont and Rhode Island, and Connecticut.

The January issue of the ***Marine Observer***, the monthly review of the Marine Division of the Meteorological Office, contains the first of a useful series of articles dealing with radio telegraphy and weather forecasting. The series previously appeared in the first volume of the ***Marine Observer***, when articles on weather forecasting that had formerly appeared on the monthly weather charts were replaced and extended. The first chapters deal with observation, scales, and the drafting of reports. The practical information it supplies should be of use to many besides sailors. There is now a total of 500 ships regularly contributing observations to the Meteorological Office. Many of these make daily reports to 'all ships,' and the others are invited to do so with the view of each ship-master being in a position to make his own weather chart and forecast.

The scientific staff of the Madras Government Museum "has had," says the Report for 1925-26, "to devote almost the whole of its time to investigations." Coins and bronzes have been catalogued, a guide to the flowering plants of Madras City and its immediate neighbourhood has been pushed forward, the littoral fauna of Krusadai Island has been surveyed, and the life-histories of local insects have been studied. This work has enriched the collections but has delayed the improvement of the exhibited series.

We have received the new edition of Messrs. C. Baker's (244 High Holborn, W.C.1) catalogue of microscopes and accessory apparatus. The B.L.M. series of microscope stands has been extended and includes mineralogical models, and the prices have been drastically reduced. A new $\frac{1}{6}$-in. oil immersion lens, N.A. 0·95, has been added to the series of objectives, which may replace the medium-power dry lens when oil-immersion high-power lenses are also being used, and is serviceable for dark ground illumination. A new series of eye-pieces has been computed by Lieut.-Col. Gifford, "Gifford ortho-chromatic," which are claimed to be an improvement both in field and in definition, the field being half as large again as with the ordinary Huyghenian type.

ANOTHER volume of "Alumni Cantabrigienses," compiled by the late J. Venn and J. A. Venn, is announced by the Cambridge University Press. It will complete the first half of the work and bring the biographical record of all known Cambridge men down to the year 1751.

MESSRS. Longmans and Co., Ltd., announce for early publication "Flame and Combustion in Gases," by Prof. W. A. Bone and Dr. D. T. A. Townend. The book will review the results of modern research and the present state of science regarding gaseous combustion and explosions. It will consist of five sections, dealing respectively with the principal discoveries from the time of Boyle to the end of the Bunsen era (1660–1880); ignition phenomena, flame propagation through explosive mixtures, detonation flame structure and temperatures; pressure development during gaseous explosions in closed vessels; the mechanism of combustion; and catalytic or surface combustion.

NOTICE is given that applications for the Government grant for scientific investigations for the present year must be received by, at latest, March 31, at the offices of the Royal Society, Burlington House, Piccadilly, W.1. The applications must be upon a printed form obtainable from the Clerk to the Government Grant Committee, c/o the Royal Society.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A demonstrator in bacteriology at University College Hospital Medical School—Prof. A. E. Boycott, University College Hospital Medical School, University Street, W.C.1 (Feb. 7). An assistant chemist under the Northern Coke Research Committee—Prof. Briscoe, Armstrong College, Newcastle-upon-Tyne (Feb. 7). A male medical inspector of factories—The Industrial Division, Home Office, Whitehall, S.W.1 (Feb. 21). A senior lecturer in anatomy in the University of the Witwatersrand, Johannesburg—The Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2 (Feb. 28). The Stevenson lectureship in citizenship in the University of Glasgow—The Secretary, University Court, The University, Glasgow (Feb. 28). A lecturer and demonstrator in organic chemistry in the University of Sydney—The Agent-General for New South Wales, Australia House, Strand, W.C.2 (Feb. 28). An assistant Government analyst in Nigeria—The Private Secretary (Appointments), Colonial Office, 38 Old Queen Street, S.W.1 (Feb. 28). A Director of Antiquities in Palestine—The Under-Secretary of State for the Colonies, Colonial Office, Downing Street, S.W.1 (March 14). A helminthologist at the Imperial Institute of Veterinary Research, Muktesar, P.O. Ritani, U.P., India—The Director, Imperial Institute of Veterinary Research, Muktesar, P.O. Ritani, U.P., India (March 15).

ERRATUM.—In NATURE of Jan. 22, p. 114, col. 2, line 20 ("The Life of a Nilotic Tribe"), for "effect" read "affect."

Our Astronomical Column.

COMETS.—Mr. H. E. Wood, of Johannesburg, has telegraphed the following parabolic orbit of the new comet 1927 *a* discovered by Mr. T. B. Blathwayt.

$$T = 1927 \text{ Feb. } 12{\cdot}720 \text{ U.T.}$$

$$\left.\begin{aligned} \omega &= 228^\circ\ 52' \\ \Omega &= 18\ \ 40 \\ i &= 90\ \ 31 \end{aligned}\right\} 1927{\cdot}0$$

$$\log q = 0{\cdot}02522$$

An ephemeris deduced from these elements shows that the comet is unlikely to be seen in Great Britain, for it will remain below the horizon until April, and after that will only be above it in a bright sky. Its track lies through Scorpio, Ara, Telescopium, Pavo, Indus, Toucan, Phœnix, Fornax, Eridanus. It is nearest to the earth, 106 million miles, in mid-February. It should then be a conspicuous telescopic object for southern observers.

The Comas Sola object of Jan. 10 is probably a minor planet. Its approximate position on Jan. 29 will be R.A. $7^h\ 51^m$, S. Decl. 3° 14′. There is not yet sufficient material to hand to deduce the orbit.

A NEW REFLECTING TELESCOPE FOR EDINBURGH.—An article in the *Scotsman* of Jan. 11 contains the welcome announcement that the Observatory at Blackford Hill, Edinburgh, is shortly to obtain a large reflecting telescope of Cassegrain type, together with a spectrograph. The exact dimensions are not stated, but as it will be "at least as great as any other in this country," its minimum aperture may be presumed to be 30 inches. The proposed field of work is stellar photometry and spectroscopy. The useful work that has been accomplished in these fields in recent years at Edinburgh gives rise to the hope of very important results being obtained when the new instrument is in working order. The article also gives an interesting sketch of the history of the Observatory, which started on Calton Hill about 1818, and was moved to its present site in 1889 as a result of the benevolence of the late Lord Crawford, who offered his valuable collection of instruments and books on condition that the State provided proper buildings and maintenance for them. The offer was accepted and the new department placed under the Scottish Office.

A LARGE SUNSPOT.—A large single sunspot which was seen with the naked eye was on the sun's central meridian on Jan. 19 and continued on the disc until Jan. 25. This is the third spot or group of spots large enough to be seen this year without telescopic aid. Other particulars are as follows:

No.	Date on Disc.	Central Meridian Passage.	Latitude.	Area.
3	Jan. 13-25	Jan. 19·3	25° N.	1/1100 of sun's hemisphere.

A number of other spots across the sun's disc and patches of bright faculæ at the east and west limbs have been located with ease in small refracting telescopes 2 in. or 3 in. in aperture.

Research Items.

Gypsy Marriage Customs in Eastern Rumelia.—In the course of a correspondence on the language and conditions of the gypsies of Eastern Rumelia which passed between Dr. A. G. Paspati and Smart and Crofton in 1879, when the first named was in Constantinople, some interesting details were given of gypsy betrothal and marriage customs. In one letter of the series, which is published in Part 3, vol. 5 of the *Journal of the Gypsy Lore Society*, it is stated that the friends, male and female, of the bridegroom go to his intended bride's residence and demand her of her father. If he consents, the bridegroom and his friends go again to the father's house the next day and each receives a present, generally a handkerchief. The bride and bridegroom are then left alone while the party adjourns to an adjacent wine-shop, where they remain until evening. The bride and bridegroom dine together, drinking out of the same wooden bottle as a sign of love. After dinner the bridegroom leaves and the betrothal is considered valid. On the Friday before the wedding, a friend of the bridegroom goes with a wooden bottle to the bride, offering the groom's congratulations, and then with a donkey goes to the forest to cut wood for the ceremony. In the evening of the same day paste is kneaded for a cake to be baked and eaten on the wedding day. On the following day relatives of the groom carry the dowry to the bride. On the Sunday after the wedding the transparent red veil worn by the bride is taken off her face by the bridegroom's man by means of two slender vine sticks and laid on a rose-bush. He then carries two buckets of water on his shoulders taken from any fountain, and these the bride oversets thrice. The fourth time she follows him to the house of the bridegroom, kissing the hands of all passers-by.

A Crystal Mask from Tibet.—Mr. H. C. Beasley has published in *Man* for January an illustration of a remarkable crystal mask from Tibet. The mask is that of the goddess Palden Lhamo, one of the Eight Terribles, as is shown by a third eye in the middle of the forehead. The body of her face is worked up from a lump of rock crystal, the features are applied in gilt bronze, and the teeth are probably human, while the eyes are of ivory. It is said that the mask was used to attract evil demons, who were then dealt with by the officiating lama. Palden Lhamo corresponds to Kali of Indian mythology, and in Japan appears as a goblin under the name Mitsume. The Chinese god of disease Yü-yüen, recognisable by his long teeth, also has a third eye, and is probably derived from Palden Lhamo. She was also believed by the Tibetans to have been reincarnated in Queen Victoria. As one of the Eight Terribles, Palden Lhamo rides a chestnut mule, the offspring of a winged mare, and the gift of the goddess of the sea. She carries a string of skulls, and she feeds on corpses given her by the goblins who haunt graveyards, while her scanty garment is a girdle made of the skin of a recently flayed man. She is often shown drinking blood from a cup formed of a human skull.

Cocaine.—Prof. E. Poulsson contributes an article to the *World's Health* for December last (which appears in a new and more attractive cover than formerly) on the properties, use, and abuse of cocaine. The coca plant, coca chewing, and the properties of cocaine as an anæsthetic are described. The effects of cocaine upon the drug addicted are then summarised. These consist of a first stage of well-being or happiness, followed by a condition of restlessness and anxiety in which self-control may be lost. Continual snuffing of the drug causes nasal catarrh and ulceration of the nasal septum. An extremely characteristic effect is an intense pricking and creeping sensation in the skin, so that the habitué has the impression that it harbours worms or lice, and seeks to get rid of these by digging with his nails or the point of an instrument, so that the body may become covered with sores and ulcers. This form of drug abuse is very widespread, but the author considers that it will be more easy to combat than the use of opium and its products. Coca plantations are of comparatively recent origin and are far from possessing the economic importance of opium plantations. It is possible also to prepare synthetically drugs which possess the paralysing power of cocaine on the sensory nerves but have little or no effect on the brain. The more these are used, the less will become the medical need for cocaine itself.

Protection of the Great Skua.—Few birds have so restricted a range as the great skua, which in Britain formerly nested only in the Shetland Isles. Its present position is discussed in the *Scottish Naturalist* (1926, p. 169). It is shown that as a result of protection, first because it kept away the sea-eagle, and more recently under the Wild Birds Protection Acts, the great skua has extended its breeding range to several new areas. It is suggested that protection has now gone far enough, and that some restraint might well be placed on the further multiplication in certain areas of this robber and pirate. Its spread in one locality is shown to have been responsible for the complete disappearance there of black-headed gulls, arctic terns, red-throated diver, kittiwakes, and whimbrel, and even the strong herring gulls and lesser black-backed gulls have been reduced to a few pairs on ground which they formerly dominated. Strange to say, the only bird which seems to hold its own in face of the aggression of these great skuas is the common snipe.

The Warble-fly in Denmark.—Denmark is pre-eminently a cattle country, and on this account the damage done by the warble-fly had in 1903 reached the immense sum of £275,000. The matter had become so serious that the legislature took up the question, and in March 1923 passed a first law compelling stock-holders to rid their cattle of warble maggots, or failing such action to submit to the destruction of the pests by representatives of the parish councils at the owners' expense. An account of the legislation and its effects, by Harald Faber, Agricultural Commissioner to the Danish Government, appears in the *Journal of the Ministry of Agriculture* (Jan. 1927, p. 905). The results are striking. Of the 793,250 cattle herds in Denmark, 124,893 were freed from maggots in 1923; in 1924 178,044 herds were examined by authorised inspectors, and in 29·6 per cent. of these maggots were found and exterminated. The policy of the Government has been very satisfactorily reflected in the condition of Danish hides. Before the first law was passed in 1923 (it has been continued by subsequent enactments) the ratio of hides damaged by maggots in 1922 was 20 per cent.; in 1923, after a partial application of the law, damaged hides represented 15 per cent.; in 1924, with the law in full force, the number had fallen to 4·5 per cent., and in 1925 it was 4 per cent. The monetary saving has naturally been very considerable.

Small Holdings and Forestry.—Several of the papers read before the subsection of Forestry at the Oxford meeting of the British Association last year are reprinted in the half-yearly issue (Oct.) of the *Transactions of the Royal Scottish Arboricultural Society*. Perhaps the most important of these is the presidential address by Lord Clinton, entitled "Small Holdings in Relation to State Forest Policy." Much of the ground covered is well known to the scientific forester, especially on the Continent of Europe. It is satisfactory to British foresters to recognise that this aspect of a forest policy is now beginning to become appreciated in Great Britain. It is, in fact, the recognition of the absolute dependence of the forest for the bulk of its labour on some system of small agricultural holdings which afford a certain amount of occupation to the agriculturist at certain seasons of the year, full-time employment being obtainable at other seasons in the forest. Under the scheme adopted by the Forestry Commission, holdings are limited to 10 acres, and 150 days' work in the forest is guaranteed, but more may be granted. The advantages on both sides are obvious. The smallholder, cultivating a small area of land and with a small herd of stock for which grazing at specified times may be available, finds his main occupation in the forest. The State, outside the comparatively small full-time staff it is possible to employ in the management of forest areas, has at hand a labour supply which becomes increasingly skilled in forest work. Finally, the country acquires a settled, contented, and hardy community settled on the land. Small holdings, from the purely agricultural development point of view, are still a doubtful policy to follow. From the forestry viewpoint their successful inauguration in Britain is essential to the future progress of the afforestation work.

Russian Work on Microbiology.—The Bureau of Agricultural Microbiology of the State Institute of Experimental Agronomy at Leningrad, which is under the directorship of Prof. S. P. Kostychev, has commenced the publication of a *Bulletin*. The first volume has recently appeared, and it contains an interesting series of papers on biodynamics of soils, comprising results of extensive studies of the bacterial population of various soils and its chemical activities. Other papers include a study of the chemical conditions of fixation of atmospheric oxygen by *Azotobacter agili* (Kostychev a.o.); results of a detailed research in the symbiosis of various bacilli of milk (Ulrich), and two papers on the bacteriological method of control of rodents. Unfortunately, none of the papers is provided with a summary in a western European language, and this will restrict their usefulness to scientific workers of other countries.

Local Coast Submergence.—An example of local and relatively rapid submergence of the coast of Galveston Bay is described by Prof. D. W. Johnson and Mr. W. E. Pratt in the *Geographical Journal* for January. In 1917 an oil-field was started near the mouth of Goose Creek, not far from Houston, Texas. Since then, several million barrels of oil have been taken from the field with the result that the Gaillard peninsula, near the centre, and adjacent low coastal areas, have become submerged. In an area two miles and a half long by one mile and a half wide the maximum subsidence is now more than three feet. The ground involved consists of recent sands and clays only slightly more compacted than sea-bottom muds, and the oil is extracted mainly from depths between 1000 ft. and 4000 ft. Prof. Johnson is convinced that the subsidence is purely local and has nothing to do with any general sinking of the gulf coasts. Moreover, its area corresponds with the area of extraction, it is bordered by earth fractures, and it sinks steadily as extraction continues. Prof. Johnson cites this case as a rare, if not unique, example of subsidence of the earth's coast following the exploitation of an oil-field.

Exploration of the Russian North.—The Institute for the Scientific Exploration of the North at Leningrad (*Sjezdowskaja* ul., No. 1-3) is publishing a series of its transactions in separate parts, each part containing either one complete paper, or several papers dealing with the same subject. So far, in the interval 1920–1927, thirty-four parts have appeared, dealing with widely varying aspects of the country under exploration. More numerous than any others are the reports on geography, geology, and mineral resources, which include accounts by A. E. Fersman on the tundras of Kola Island (Part 29), and on the Chibina Range of the same island (Part 16); by A. A. Grigoriev on the geology and geological history of the Bolshezemelsk tundra (Part 22); by A. A. Tchernoff, D. I. Stcherbanoff, D. Beliankin, and others, on the mineral deposits of various regions of northern Russia (Parts 10, 18, 20, 24, 35); by V. A. Lindholm on the post-Pliocene mollusca from Murman (Part 12), etc. Another valuable set of papers deals with fish and fisheries of north Russian seas as well as of the Petchora River. These papers include keys to the sea-fishes by Prof. N. M. Knipovitch (Parts 27 and 31); an exhaustive study of the White Sea herring by A. J. Rabinerson (Part 25); a description of fishes and fisheries of the Petchora River by Prof. W. K. Soldatoff (Part 17), etc. Part 19 contains studies of hydrology, currents, and fauna of the Barents Sea by Prof K. M. Derjugin (including descriptions of some new species from various orders). Ornithologists will find an interesting account on the nesting colonies ("loomeries") of *Uria troille* L. in Novaya Zemlya, in Part 26, by G. P. Gorbunoff. Several papers deal with the economic aspects of the country, these comprising papers by N. Volens on the industries, and especially the agriculture, of the Petchora region (Part 21) and of the Murman coast (Part 28), while S. V. Kerzelli deals specially with reindeer breeding (Part 13). One paper, by V. G. Bogoraz, is devoted to the problems of ethnography in northern Russia.

Tar-distillate Sprays.—The Ministry of Agriculture and Fisheries has issued (Dec. 1926) information based on experimental evidence as to the best use of tar-distillate sprays for fruit trees. These new 'proprietary' washes, which are rapidly superseding the caustic sprays, are made by emulsifying a certain part of the tar-distillate. Carbokrimp, Chafers' No. 1 Winter Wash, Ialine Tar Oil Winter Wash, and Mortegg, applied in January at 7½-10 per cent. concentration, were found successful in controlling Rosy Apple aphis and Apple Sucker, while 6 per cent. solutions satisfactorily reduced both aphis and 'brown rot' on plums. Apple and plum trees may also be considerably freed from the caterpillars of the winter and tortrix moths, but these washes are ineffective in reducing apple scab and 'red spider'; if, however, this latter pest occurs on gooseberries, it can be successfully checked by the same sprays. In order to ensure success, the instructions issued must be carefully followed, especially as regards the time at which to carry out the operation. Spraying can only be done with safety when the buds are dormant, *e.g.* up to the end of January for plums, and somewhat later for apples. Further, the washes should not be applied before December, in order to ensure that the various pests have laid their eggs. Fine, but not frosty, weather is the most suitable. If the water of the district is very hard, an addition of 1 lb.-2 lb. powdered size or glue per 40 gallons is advised. An annual treatment is recommended, as the effect may be more marked in the year following the season of application. Besides the destruction of insect pests, a luxuriance of foliage produced in the succeeding year is noticeable, although any green leaves in actual contact with the spray will be liable to scorch.

THE MERCURY-ARC POWER RECTIFIER.—Great progress has been made recently in improving the mercury-arc power rectifier for converting alternating current into direct current. It is now very widely used. In the December issue of the *Review* published by the Brown Boveri Co. of Baden, in Switzerland, we learn that one of their rectifiers was tested at a direct current pressure of 8000 volts. It produced a pressure of 12,000 volts between the anodes of the device when the transformer was connected for three-phase working. No disturbance occurred when the rectifier was interrupted under a load of 900 kilowatts. This shows that the voltage limit has not yet been attained. The main difficulty that has to be overcome is to disperse by artificial means the heat produced in the rectifier, as it is a stationary piece of apparatus. In the same *Review*, Mr. Seitz writes a valuable paper on the methods employed for cooling rectifier sets. The methods generally employed are direct cooling by water, indirect cooling by water, and cooling by natural or forced draught. When a continuous water supply cannot be guaranteed, a water flow alarm is supplied so that serious trouble can be avoided. When the water is very hard or when it is impure, indirect water cooling is employed, a special pump being used to keep up the circulation. Natural draught is only used when the load is very small or intermittent and when the room temperature does not exceed 15° C., thus permitting a temperature rise of about 35° C. for the rectifier. For medium and large-sized rectifiers, forced draught is used, centrifugal fans being employed to cool pipes containing circulating water. For a direct current of 1000 amperes and a mean temperature rise of 25° C., the power expended in the fan and circulating pump does not exceed one horse-power.

ESTIMATION OF PHOSPHATES IN CALCAREOUS SILOS.—In the Chemical Series of the *Memoirs of the Department of Agriculture*, India, 8, No. 6, S. Das shows that in the case of highly calcareous soils, Dyer's citric acid method for the estimation of available phosphoric acid is unsuitable, and if the calcium carbonate content of the soil ranges from 1 to 7 per cent., is equally unsatisfactory for potash determinations. After experimenting with various salt solutions, a new and trustworthy method for use with such soils is described. A 1 per cent. potassium carbonate solution is employed for the soil extraction, the proportion of soil to solvent being as 1 : 10, and after shaking for 24 hours at laboratory temperature, the dissolved P_2O_5 in the extract is estimated by the ammonium molybdate method. The underlying principle of the action of 1 per cent. potassium carbonate solution on calcareous soils is twofold; a reaction takes place with any dicalcic or such other phosphates present, with the production of insoluble tricalcium or other phosphates and of soluble potassium phosphate; and, further, any phosphorus in organic combination in humus is also dissolved.

MARINE STEAM TURBINE PROGRESS.—Marine engineering practice sometimes leads, sometimes follows, land practice. In power stations ashore, advances have been made in the matter of higher steam pressures, the highest on record being 1200 lb. per square inch. The use of steam at 300 lb. to 400 lb. per square inch is fairly common, and considerable economy has been obtained by the utilisation of such pressures. Attempts are now being made to adopt higher pressures in ships, and an account of the latest advance is contained in a paper on "Progress in Economy of Turbine Machinery on Land and Sea," by Sir Charles Parsons, Mr. R. J. Walker, and Mr. Stanley Cook, recently read to the North-East Coast Institution of Engineers and Shipbuilders. Accompanying the discussion of the value of higher pressures, superheating, and other features of modern practice, are some historical notes and tables giving important details of the various turbine installations, both ashore and afloat, which have in turn created records, and at the end of the paper there is an account of the notable vessel, *King George V.*, launched on the Clyde last summer. Though Loftus Perkins more than forty years ago crossed the Atlantic in the *Anthracite*, using steam at 350 lb. per square inch pressure, general marine practice hitherto has demanded no more than 200 lb. to 250 lb. per square inch pressure in the boilers. In the *King George V.*, however, a vessel of 3500 horse-power, the Parsons-geared turbines are supplied with steam at 550 lb. per square inch superheated to 750° F., the steam being generated in Yarrow boilers. After the builder's trials the *King George V.* was placed on service on the Clyde and ran for three weeks to the end of the season. Consumption trials were then carried out, when with coal having a gross calorific value of 13,880 B.T.U., the fuel consumed worked out at 1·1 lb. per shaft horse-power per hour, thus easily beating all previous records hitherto obtained at sea.

ELECTRIC TRACTION.—In the *Journal of the Institution of Electrical Engineers* for January, F. Lydall gives a review of the progress of electric traction throughout the world which puts the progress made in Great Britain in a much more favourable light than has been generally accepted. Broadly speaking, we can divide railway electrification schemes into suburban and main line schemes. In Great Britain electrification is almost wholly confined to suburban schemes. The Southern Railway utilises it largely. It recently extended the electrification of the south-western section by the addition of about 70 miles to the length of track equipped, and the conversion of about 250 miles of suburban lines on the south-eastern section. The 127 miles of track on the Brighton section already equipped with overhead wires are being gradually converted to the third rail system. Considerable additions are also being made to the electrified portion of the line. The Southern Railway will soon have 854 miles of track electrified on the same third rail system. In France suburban electrification is much less prominent, the principal schemes being the main line electrifications on the Paris-Orléans and the Midi railways. In Switzerland electrification of the main lines has been carried out on a large scale. In Italy electrification has been in progress for the past twenty-five years, and the mileage of track equipped exceeds 600. In Germany the electrification of railways, especially in Silesia and Bavaria, is proceeding very rapidly. By the end of the year the electrified track will be about 700 miles. In Austria the progress has not been so rapid, owing to financial stringency. It is, however, in the United States that much the greatest progess has been made. As electric operation can provide facilities greatly superior to those obtainable from steam operation in respect of schedule speed, and volume of traffic, it is natural that all the great cities in the eastern states have extensive urban and suburban services. In no less than fifteen cities of the United States steps have been taken towards the elimination of smoke from locomotives by electrification or other means.

Researches on Sex-Change in the European Oyster.

THE fundamental fact about the breeding of the edible oyster is that the manifestations of this function may vary individually and in gross from season to season in a given locality, and, in general, differ also in different localities roughly according to the degree of warmth of their environment.

A modern research on the breeding of this mollusc should therefore include (*a*) adequate records of the environmental conditions, of which—if the animals are living under healthy conditions—temperature variation may be postulated as one of the most important; (*b*) a significant amount of healthy material the age of which has been unimpeachably determined by experimental methods; and (*c*) experimental observations on the successive sex-conditions during one or more years of a significant number of individuals which are living under conditions as nearly natural as it is possible to attain. The modern standard of research is very high, and it is impossible for any one worker to attain it on this problem without lengthy and large-scale operations.

During late years considerable attention has been again given by workers in various parts of Europe to an inquiry on the sex-conditions and sex-changes of the European oyster (*O. edulis*). In 1925, R. Spärck, a young Danish biologist, published a valuable paper[1] on the subject, giving the results of several years' work (1919 to 1923) on oysters obtained from the Limfjord. In a useful review of the literature on this subject, Spärck clearly shows the confusion which existed even down to recent years with regard to our ideas of sex-phenomena in one of the commonest economic molluscs. The difference in opinion which existed amongst well-accredited workers in the nineteenth century is well brought out by Spärck, who finds in the literature that oysters are described variously as comprising hermaphrodite, male, and female individuals (Davaine), all potentially hermaphrodite (Lacaze-Duthiers), all mainly male or female (Mobius and Hoek), that oysters are simply protandric hermaphrodites (a popular conception even in recent years); that they do not spawn until three to four years of age; that they do spawn at one year; that sex-change does occur (Davaine) or does not (Lacaze-Duthiers); that there are always 100 times more males than females (Davaine); that figures given show that there is a higher porportion of females than Davaine states (Mobius and Hoek). From these details there can be no doubt that the earlier workers had found out or surmised most of the facts, but the difficulty at the present time is to sort them out and place them in their true order; hence the need for modern critical research.

The confusion in the past has been largely due to the failure of workers to produce experimental facts, and also to the failure to differentiate fact from opinion; and indeed, until more biological work is stated in the order, experiment, observations, inference, the cycles of words used in the oyster literature of the nineteenth century are likely to be repeated in the twentieth.

In Spärck's work the difficult subject of inshore temperature variation is accounted for with a daily record at 8 A.M. of the water at Oddesund, at a position not precisely stated and the daily temperature-variation of which is not given, nor its relations to the variation on the beds whence oysters were taken for examination. Charts of the Limfjord show the 3-fathom line to lie close to the shore at Oddesund itself, but about half a mile to a mile off shore in other parts. It is well known that the temperature of shallow water on such an extensive foreshore will follow that of the air closely, and in summer the mean temperature will rise to a varying degree above the mean temperature of the air (compare when plotted together, the author's Fig. 15, which is apparently *mean* air, and Fig. 11), unless replaced by tidal water sweeping in directly from the open sea. It might easily happen, therefore, that while the temperature at 8 A.M. at Oddesund on a given day were 14° C., at another position a mile away and half a mile from the shore the temperature might easily at some period of the day be 16° C. or more (compare the author's statements on pp. 41 and 21). It is not sufficient to assume that the surface readings at Oddesund at 8 A.M. in the morning will give a correct picture of the variation in temperature over the oyster beds; the assumption is unjustifiable, but if it were justified the proof should be given. The author's treatment of temperature records from other regions is mostly unconvincing in a similar manner. The oyster biologist should indeed command a good general and practical knowledge of hydrography, and ought to make constant use of thermometric instruments on the beds, or at least to have one up his sleeve.

Those conclusions which Spärck bases on the Oddesund temperature records—for example, that there is no fixed temperature limit below which oysters will not spawn—cannot, therefore, be regarded as substantiated by adequate observational data. His definition of the oyster as a *protandric alternating hermaphrodite* is, however, supported by an increasing body of evidence, and may stand the test of time. His observations on seasonal sex-condition lead him to a conclusion similar to that formerly propounded—apparently unknown to the author—by B. Helland Hansen, namely, that complete egg-development is a product of time and temperature (calories). There will no doubt be sufficient data accumulated in the near future to settle this interesting problem.

It is also stated that egg-development ceases at 10° to 12° C.; that at (sustained summer periods of) temperature of 20° to 22° C. each individual may become female once a year; or only every three or four years (at sustained summer periods) at 14° to 16° C.; but the two latter at least of these statements are debatably inferential and not founded on experimental or demonstrated data.

Three valuable cases of sex-change from male to female were observed experimentally, but the number of failures to observe change is not noted, nor are the sex-changes themselves critically discussed. An observation is made by Spärck, that in regions of low salinity (and relatively high temperature) in the Limfjord, oysters appear to grow much more slowly than in regions of high salinity and relatively low temperature (p. 21); one suspects that the author is arguing in a circle from size at breeding to age and age to size, but if experimental data could be obtained to verify these statements, an important addition would be made to our knowledge on shell growth. Besides interesting remarks on seasonal feeding, on greening, on enemies, and on the fluctuations in the local stock of oysters, Spärck discusses the general effect of external conditions on sex, and arrives at the conclusion that "an alteration in the surrounding conditions results in an alteration in the kind of sex."

J. H. Orton.

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[1] "Studies on the Biology of the Oyster (*Ostrea edulis*) in the Limfjord, with Special Reference to the Influence of Temperature on Sex-Change." Report of the Danish Biological Station, 30, 1924 (1925).

The Third Pan-Pacific Science Congress.

THE third Pan-Pacific Science Congress was held at Tokyo on Oct. 30–Nov. 11, 1926, under the auspices of the National Research Council of Japan and through the generosity of the Imperial Japanese Government. It must well have been one of the most remarkable scientific meetings ever held. The main objects of the Congress, like those of the first held in Honolulu in 1920, and of the second held in Australia in 1923, were (1) to initiate and promote co-operation in the study of scientific problems relating to the Pacific region, more especially those affecting the prosperity and well-being of the Pacific peoples; and (2) to promote a feeling of brotherhood and to strengthen the bonds of peace among Pacific peoples. It was laid down that all branches of physical and biological science formed proper subjects for discussion, provided that they bore upon some Pacific problem.

The Congress was attended by 150 delegates from countries outside Japan, and by 400 Japanese members. At the opening meeting, speeches of welcome were made by the Prince of Kan-in and by the Prime Minister of Japan. In addition to the general opening and final meetings, two joint meetings of all members of the Congress were held. At the first of these such papers were read as constituted a review of the present state of knowledge of the physical and biological oceanography of the Pacific, and at the second such papers as dealt with special plans for international co-operation. At five other sessions the different branches of science were grouped together so as to form two broad divisions, namely, the physical and the biological. At the remaining sessions simultaneous sectional meetings were held, there being sections for astronomy, meteorology and terrestrial magnetism, radio waves, geology, seismology, architecture, botany, zoology and fisheries, agriculture, geography, hygiene and medicine.

The object of the broad divisional meetings was an attempt to realise solidarity of feeling and action, and this attempt was eminently successful. At the meetings of the physical division the papers were grouped under the following headings: Meteorological and time-service by radio transmission and causes which give rise to its disturbance; form of the geoid as deduced from geodetic observations, measurements of gravity and plumb-line deviations; suitable projections for maps on different scales; crustal movements and geotectonics, earthquakes, crust-tides, and variation of mean sea-level; study of volcanoes in their various aspects; thermal springs; metallogenetic epochs and their bearing upon structural unity; distribution of rare elements.

At the meetings of the biological division the subjects were grouped under the following headings: Rational methods for the protection of useful aquatic animals and plants; genetics in relation to the improvement of important crops, more particularly rice, and of live stock; distribution of bonitos and tunnis and their ecological studies; distribution and life-history of freshwater eels; international co-operation in the investigations of pelagic fish eggs and larvæ; preservation of natural monuments; rational methods of storing cereals; scientific bases for plant quarantine.

In all, more than 430 papers were presented and briefly described, printed abstracts being provided in advance. The full text of the papers, when published, will be of enormous value.

At the final general meeting many resolutions were passed on the recommendation of divisions, sections, and special committees, and, in particular, rules were drawn up for the constitution of a permanent Pacific Science Association, the function of which will be to organise future congresses. An invitation from the delegation of the Netherlands East Indies to hold the next congress in Java in 1929 was accepted.

Before and after the Congress long excursions were made, covering the land from Hokkaido to Kyushu, while two days in the middle of the Congress were devoted to shorter excursions. In all, there were about twenty excursions, and practically all overseas delegates were shown the beauties and wonders of Nikko, Hakone, Kyoto, and Nara.

Throughout the Congress itself and during the excursions, all overseas delegates and their families were the guests of the Japanese. The extent of the hospitality was only equalled by the perfect organisation, and both were the wonder of all visitors. The president of the Congress was Prof. J. Sakurai, the vice-president Prof. A. Tanakadate, and the general secretaries Profs. N. Yamasaki and K. Matsubara. In consideration of the great importance of these congresses, from both the national and international viewpoints, the Japanese Government, upon the recommendation of the National Research Council, had made a grant to be used for defraying the expenses.

Social functions formed a prominent part of the whole proceedings. Three garden parties were given by members of the Imperial family, and others by the Minister for Foreign Affairs and Baron and Baroness Fujita. Dinners were given by the Prime Minister, the president of the Congress, and the Mayors of Tokyo, Kyoto, and Osaka, while luncheons were given by the presidents of the Imperial Academy and of the Pan-Pacific Association of Japan. Theatrical performances of distinctive Japanese type were provided by Baron and Baroness Mitsui, and by the directors of the Imperial Theatre, while there were entertainments at each of the mayoral dinners. In addition there was much hospitality and entertainment of a more sectional and private character. No delegate from overseas will ever forget the cordiality of the welcome received from all types of Japanese citizens. J. P.

Loutreuil Foundation of the Paris Academy of Sciences.

THE Paris Academy of Sciences received thirty-three applications for assistance under the Loutreuil Foundation, and has made the following grants:

(1) Establishments specially named by the founder. Muséum national d'histoire naturelle (15,000 francs), École nationale vétérinaire de Lyon (7000 francs), École nationale vétérinaire de Toulouse (7000 francs). These three grants are for the same purpose, to permit these establishments to complete the sets of foreign periodicals in their libraries which have been interrupted during and since the War.

Institut national agronomique. 3000 francs to Jean Guérillot, for the purchase of apparatus for carrying out researches on the action of radio-activity in plant biology.

(2) Establishments admitted for a year by the president.

Conservatoire national des arts et métiers. 15,000 francs to Léon Guillet for the installation of a radiospectrograph in the metallurgical laboratory. 2500 francs to Emilio Damour for the purchase of apparatus for the glass laboratory.

(3) Independent requests.

4000 francs to Charles Alluaud, as a contribution to a zoological expedition to Morocco.

6000 francs to Benjamin Baillaud, for the construction and installation, in the time signal department of the Paris Observatory, of a pendulum maintained by light rays and a photo-electric cell.

2500 francs to Jules Baillaud for carrying on experiments with the view of establishing a primary standard of light.

6000 francs to Henry Chabanier, for the purchase of apparatus for carrying out researches on nephritis, and particularly on the mechanism of oedema resulting from lesions of the kidneys.

3000 francs to Henri Chaumat for the construction of a new wattmeter with an arrangement permitting the determination of the angle of phase of a magnetic field and of the current producing it.

9000 francs to the Comité français de Géodésie et Géophysique (Section of Atmospheric and Telluric Electricity) as a contribution to the cost of the sixth expedition dealing with the new magnetic network of France.

3000 francs to Hipployte Janvier for his biological studies in the Chilian Hymenoptera.

2000 francs to Paul Nottin for the continuation of his researches on the saccharification of starch.

5000 francs to Jean Mascart for assuring the publication of documents concerning the study of the variable stars, centralised at the Lyons Observatory.

2000 francs to Paul Pallary for his researches on the fauna of Morocco and the extension of the glacial régime in the Moyen-Atlas and the upper basin of Oumer Rebia.

10,000 francs to Pierre Teilhard de Chardin as a contribution to a new palæontological expedition in China.

9000 francs to Jean Thibaud for extending his researches on the structure of the atom and the radiations of radio-active substances.

4000 francs to Henri Deslandres for the publication by the Meudon Observatory of synoptic charts of the upper solar atmosphere and the details characteristic of this layer.

2000 francs to Joseph Guillaume to assist him to continue, in his private observatory, the observations which he had pursued for thirty-three years at the Lyons Observatory.

6000 francs to the Comité de patronage de la faune coloniale française, for starting this important work.

6000 francs to the Faculté française de médecine de Beyrouth for contributing to the publication of the "Flore de Syrie."

University and Educational Intelligence.

Birmingham.—The subject of the Huxley Lecture to be delivered by Prof. Elliot Smith on Feb. 1 is "Science and Culture," the realisation of Huxley's ideals. The lecture will be open to all members and friends of the university.

Cambridge.—Through the University Association, a sum of £1025 has been bequeathed by the late Michael Emil Lange, of Christ's College, for the further endowment of the University.

Edinburgh.—The International Education Board of New York has given a sum of £74,000 as a contribution to the cost of the new Department of Zoology and in recognition of the work of Prof. J. H. Ashworth, professor of zoology in the University. The new Department will be at the King's Buildings, West Mains Road.

London.—The two following courses of free public lectures at University College are announced: "Reproduction," by Dr. A. S. Parkes (on Feb. 7, 14, 21, 28, Mar. 7 and 14), and "The Action of the Sense Organs," by Dr. E. D. Adrian (on Feb. 9, 16, and 23). The lecture hour in each case will be 5 o'clock.

Oxford.—Mr. A. G. Tansley, lecturer in botany in the University of Cambridge, has been appointed to succeed Sir Frederick Keeble as Sherardian professor of botany at Oxford. Mr. Tansley was president of Section K (Botany) of the British Association at the Liverpool meeting in 1923, and is the author of a number of papers and other works on plant ecology.

Five fellowships tenable for two years, each of the annual value of £200, will be awarded in 1927 to graduates of the University of Wales. Applications for the fellowships must be received before June 1, by the Registrar, University Registry, Cathays Park, Cardiff, from whom further information may be obtained.

The International Federation of University Women held its fourth conference at Amsterdam on July 28–Aug. 2, 1926. It has published a report (pp. 176, price 1*s.* 6*d.* post free, obtainable from the Secretary, 92 Victoria Street, London, S.W.1) containing much interesting information bearing on the various subjects discussed: international fellowships for research and travel, interchange of secondary school teachers, the problem of a language of international intercourse, the means of reconciling marriage with a professional career, and several others. The accounts given by ten distinguished members of the Dutch Federation of the work of university women in Holland and its colonies are of outstanding importance, indicating as they do, with considerable fullness, the place of university women in the national economy. Prominent among the sciences in which women have shown capacity for advanced work is biology. Of 245 women in Holland who have completed university studies in this branch of science, 45 are married and have no professional occupation, 129 are teaching, chiefly in secondary schools, and 41 are scientific workers in universities, including 21 in agricultural stations and 11 in museums, etc. Of 246 who have completed a medical course, 183 are practising doctors. Nearly half of them are married (59 to medical men) and 56 of these have full-time practices; 35 medical practitioners work in the Dutch East Indies, 19 holding government appointments. In pharmacy, women assistants (1698) largely outnumber the men (308), although there are only 217 fully qualified female pharmacists to 643 male. In dentistry there are 576 men to 132 women. In the Dutch colonies there are women physicians (35), dentists (22), chemists (10), biologists (9), doctors-in-law (9), teachers (16), and one theologian.

Calendar of Discovery and Invention.

January 30, 1826.—A great achievement was brought to a successful termination on Jan. 30, 1826, when Telford's famous suspension bridge over the Menai Straits was opened and the London mail-coach crossed to Anglesey. Hitherto the passage of the Straits by boat had often been difficult and dangerous. Among the most graceful of such structures, the bridge has a central span of 579 feet. Its main features are the sixteen chains formed of flat wrought iron bars 10 ft. long, 3½ in. wide, and 1 in. thick.

January 31, 1858.—In a decade which saw the Great Exhibition, the discovery of the first coal-tar colours, the invention of the Bessemer process, and the laying of the first Atlantic cable, there was no greater experiment than the building of a steamship to run between England and Australia carrying sufficient coal for the round trip. The *Great Eastern* was begun in 1854 and, after extraordinary difficulties, was launched in the Thames on Jan. 31, 1858. Though a commercial failure, she was a splendid specimen of naval architecture and a worthy monument to her designers, Scott Russell and Brunel.

January 31, 1895.—In a letter to NATURE in September 1892, Lord Rayleigh directed attention to a slight difference in the densities of nitrogen prepared from two different sources. This letter led to the collaboration of Lord Rayleigh and Sir William Ramsay. In April 1894, Ramsay wrote to his wife, "I am at work on nitrogen but not from the commercial point of view. . . . Nitrogen of air is heavier than nitrogen from ammonia in the ratio 251 to 250. That would correspond with the addition of some light gas to the heavy one, or of some heavy gas to the light one." In August 1894 he was able to say, "I have isolated the gas. Its density is 19·075." The new gas was named argon, and the full story of its discovery was told by Rayleigh and Ramsay at a special meeting of the Royal Society held on Jan. 31, 1895.

February 2, 1891.—In 1887, Lord Rayleigh pointed out how particles of silver might be deposited in layers half a wave-length of light apart. Four years later, on Feb. 2, 1891, before the Paris Academy of Sciences, Gabriel Lippmann explained the discovery of the process of colour photography by interference.

February 3, 1851.—The idea of using a swinging pendulum to demonstrate the rotation of the earth was due to Leon Foucault, who described his experiments to the Paris Academy of Sciences on Feb. 3, 1851. Some of his demonstrations were made in the Panthéon, but when, a year or two later, the Panthéon again became a church, the pendulum was shown in motion at the Champs de Mars.

February 4, 1812.—Preserved in the Deutsches Museum, Munich, is the apparatus by which Sömmering in 1809 sent signals by electricity. His attention had been attracted to the subject by the successful use of the semaphore during Napoleon's Austrian campaign. Commencing in 1809 with communicating between points 38 feet apart, on Feb. 4, 1812, he was able to send signals almost ⅔ of a mile.

February 5, 1870.—At the Academy of Music, Philadelphia, on Feb. 5, 1870, before an audience of more than 1500 people, Henry Heyl publicly exhibited on the screen a series of posed pictures showing the movements of a couple waltzing. The effect was obtained by placing photographs round the edge of a disc which was driven step by step in strict time with the music of the orchestra. This was the first public motion picture show, and the Academy has been popularly called "the birthplace of the movies."

E. C. S.

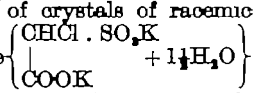
Societies and Academies.

LONDON.

Royal Society, Jan. 20.—J. Topping and S. Chapman: On the form and energy of crystalline sodium nitrate. The total potential energy has been found for a series of configurations of the ions of the crystal, by the addition of the potential energy due to the intrinsic repulsive forces between the various ions, to the electrostatic potential energy, which was calculated in a previous paper. The stable configurations of the crystal corresponding to a minimum value of this energy has been found for various values of the distance b between the N and O ions of an NO_3 group. The value of b suggested is about 0·96 Å.U., which is somewhat larger than the value of 0·72 Å.U. given in the former paper.

C. N. Hinshelwood: Quasi-unimolecular reactions—the decomposition of diethyl ether in the gaseous state. The decomposition of gaseous diethyl ether is a reaction which obeys the unimolecular law at high pressures, but becomes more nearly bimolecular at lower pressures. A sufficient amount of hydrogen completely stops the falling off in the unimolecular velocity constant at low pressures; helium and nitrogen have little or no influence, while the reaction products in considerable excess have a slight retarding influence. There are enough collisions to activate the molecules if the energy of activation is assumed to be distributed among about eight degrees of freedom. These and other 'quasi-unimolecular' reactions are most simply explained on Lindemann's theory.

W. G. Burgers: An X-ray investigation of optically anomalous crystals of racemic potassium chlorosulpho-acetate. In an investigation of crystals of racemic potassium chlorosulpho-acetate



$$\left\{\begin{matrix} CHCl\,.\,SO_3K \\ | \qquad\qquad + 1\tfrac{1}{2}H_2O \\ COOK \end{matrix}\right\}$$

by F. M. Jaeger, it was shown that these crystals exhibit an anomalous optical behaviour, and that variations occur in the angles between some of their faces. Investigation of the crystals by X-rays shows that the crystals are truly orthorhombic, and that the irregularities of their habit must be caused by a slight difference in orientation of successively crystallised layers. The optical anomalies may be due to strains in the crystals. The space-group of the crystals is Q_h^{14}, the underlying lattice Γ_0. The dimensions of the unit cell, which contains eight groups of the above formula, are $a=8{\cdot}58$ Å.U., $b=8{\cdot}60$ Å.U., $c=23{\cdot}76$ Å.U.

J. Topping: On the mutual potential energy of a plane network of doublets. The mutual potential energy of a set of coplanar doublets with their axes all perpendicular to the plane has been found at the net-points of (1) a square network, and (2) an equitriangular network. If the number of doublets per unit area be the same in both cases, the energy per unit area differs only by about 2 per cent. This result may be applied to a layer of polarised molecules on the surface of a fluid, so that a fairly definite estimate of the energy can be made for any probable mode of packing of the molecules.

D. Buchanan: Periodic orbits of the second genus near the straight-line equilibrium-points in the problem of three bodies. The particular problem considered pertains to periodic oscillations in the vicinity of the Lagrangian straight-line equilibrium-points, when the two finite bodies move in circles and the third body is infinitesimal. The first-genus orbits near these equilibrium-points were first obtained by Darwin. The orbits with which this paper is more particularly concerned are those of Class A of Moulton's 'Oscillating Satellite.' With respect to rotating axes, they have the shape of the figure 8, with the top and bottom of the 8 bent up from the page. They re-enter after one revolution. The second-genus orbits considered are in the neighbourhood of these figure-8 orbits, but re-enter only after many revolutions. The ratio of periods of orbits of the two genera is a function of distance between them at initial times.

L. F. Richardson: The deferred approach to the limit. This is an investigation of the validity of an arithmetical process, here called the 'h^2-extrapolation,' which has previously been used for solving differential and integral equations.

J. E. Lennard-Jones and **B. M. Dent**: Some theoretical determinations of the structure of carbonate crystals. Part 1. This paper provides data for the calculation of the potential energy of any crystal of the calcite type for which the forces between the constituent ions are known. Two crystals, namely, $MgCO_3$ and $CaCO_3$, are considered in detail, and theoretical determinations are made of the size and shape of the rhombohedral cells. In addition, the investigation determines an absolute value for the energy of these crystals is obtained. Part 2. A theoretical relation is obtained between the size of the rhombohedral cell of the carbonate crystals and the magnitude of the forces between the metallic and oxygen ions.

J. A. Gaunt: The first step in the approximate solution of differential equations by interpenetrating lattices.

J. W. McBain and **W. B. Lee**: Adhesives and adhesions: true chemical compounds as adhesives. Pure crystalline substances fully rival well-known adhesives in the strength of joint obtainable by them and may yield joints between optically polished metal surfaces the breaking strength of which may approach one ton per square inch. Pure liquids give results of a lower order of magnitude. In all cases the thinner the film, the stronger the joint. This rule holds for ordinary adhesives as well, provided that the film completely fills the space between the surfaces joined. There is direct parallelism between joint strength and the mechanical properties of the materials joined. Joint strength rises with tensile strength and elasticity, and falls with atomic volume and compressibility. Good lubricants with high spreading coefficients are poor adhesives. Joint strength is often much the same, whether tested in tension or in shear. Disorderly arrangement greatly enhances strength and joint strength.

W. L. Bragg: The structure of phenacite, Be_2SiO_4. The structure of phenacite, Be_2SiO_4, is examined, and an attempt made to find the positions of the silicon and oxygen atoms. The structure proposed resembles the simpler structure of the olivine group (Mg_2SiO_4, Fe_2SiO_4) in that its form may be explained as a packing together of oxygen atoms whose centres are 2·7 A.U. apart, with the atoms of metal and silicon between groups of oxygen atoms, but the arrangement is more complex. In phenacite, silicon atoms lie at the centre of tetrahedral groups, and similar positions are probably occupied by beryllium atoms. A rearrangement is achieved at the expense of slight increase in volume associated with each oxygen atom, when the structure is contrasted with such structures as $BeAl_2O_4$, where close-packing holds. The structure is determined by 21 parameters, 15 of which are measured.

P. A. M. Dirac: The physical interpretation of the quantum dynamics. To interpret physically calculations of quantum dynamics, a number of special assumptions are previously made; for example, that the elements of the matrix that represents the total polarisation determine the frequencies and intensities of the spectral lines, in analogy with the classical theory, or that the square of the amplitude of Schrodinger's wave-function determines a probability. A general method is given for obtaining physical results from a mechanics that uses non-commutative multiplication. The theory for any number of degrees of freedom is worked out. The results obtained in this way appear to be the most general that can be got from quantum dynamics, and probably give all the information that the physicist requires. For the mathematical investigation a general transformation theory of matrices of matrix mechanics is here worked out.

T. R. Merton: On measurement of intensity of spectrum lines. The wedge method of determining the intensities of spectrum lines is discussed, and a new technique is described. A comparator has been constructed for rapidly identifying spectrum lines, and at the same time determining their intensities in terms of a standard continuous spectrum.

T. R. Merton: On temperature and pressure regulation in prismatic photographs. The errors in measurement and the loss in definition in prism spectrographs, due to variations in the temperature and barometric pressure, are discussed, and a description is given of methods by which these errors have been overcome.

Geological Society, Jan. 5.—**Charles S. Elton**: The nature and origin of soil-polygons in Spitsbergen. Polygonal soils are divided primarily into mud-polygons and stone-polygons. The mud-polygons are formed in two quite different ways: there are larger ones produced by frost-expansion of the soil in winter, and smaller ones formed by drying of the soil in summer. There are probably several factors at work in the formation of stone-polygons. A new factor is described in this paper; mixed materials become differentially arranged in a vertical direction, so that there is mud below, grading into stones on the surface. The mud freezes in winter, expands, and forms regular mud-polygons, invisible from the surface at that stage. Later, as the overlying stones become disintegrated, the centres of the mud-polygons reach the surface, and when they freeze in winter exert a lateral pressure forcing the stones outwards, forming at first, rings, and later, stone networks.—**Frank Dixey**: The tertiary and post-tertiary lacustrine sediments of the Nyasan rift-valley. The series of lacustrine sediments extending along the north-western shores of Lake Nyasa, formerly thought to be of recent age, are now known to include the deinosaur beds of late Jurassic or early Cretaceous age, as well as six groups of beds ranging through Tertiary and post-Tertiary times. These sediments extend over an area 78 miles in length and 12 miles in maximum width, and they occupy the floors of several minor rifts that run parallel with the main rift-valley. The beds extend increasingly farther inland according to their age, and the oldest group (the Sungwa beds) rises to a height of 1000 feet above the present level of the lake. The different groups rest upon the worn edges of the deinosaur beds and all older rocks, and they are themselves separated by a series of unconformities; moreover, the sediments all dip towards the floor of the main rift, and each group is inclined in this direction at a steeper angle than that of the group immediately overlying it.

Edinburgh.

Royal Society, Jan. 10.—**Miss Frances M. Ballantyne**: Air-bladder and lungs: a contribution to the morphology of the air-bladder of fish. A large mass of material, embryological and adult, of ganoids, lungfish, and teleosts has been examined. The facts brought forward help to complete the evolutionary history of the air-bladder of modern fish from the right lung of the primitive ancestral form.—**George Slater**: The structure of the disturbed deposits of Moens Klint and Lonstrup, Denmark. The disturbances of Moens Klint are local and superficial and extend for 4 miles. They may be divided into two groups, in each of which the structure shows a definite relationship to a 'core' of chalk, of asymmetrical or drumloid form of roche-moutonnée outline. Thrust planes are developed on the iceward limbs of the 'cores,' and these are associated with drift-deposits intercalated in the chalk. To the south of the area seven squeezed anticlines occur separated by thrust planes. The disturbances south-south-west of Lonstrup extend for 2¼ miles. The material involved consists entirely of drift of two types, 'clay and sand,' constantly repeated, and associated with thrust-planes. The structure differs from that of the Möen area in the fact that the beds have a uniform direction of dip to the north-north-east, but agrees with the phenomena seen at Möen on the iceward limbs of the 'cores.' The Lonstrup sections represent the tectonics of a stagnant glacier as reflected in the lower englacial material.—**Errol I. White**: The fish-fauna of the cementstones of Foulden, Berwickshire. This fauna consists chiefly of fishes, which, with the exception of a few large, widely distributed species represented by odd scales and teeth, are small local forms not previously described. Five new species are recorded, and of these four belong to new generic types of palæoniscids to which the names Fouldenia, Aetheretmon, Carboveles, and Strepheoschema are given: these are interesting on account of the specialisation they show in various directions, and specially to be noted are the degeneration of the squamation in Carboveles and the platysomid-like deepening of the body in Strepheoschema.

MANCHESTER.

Literary and Philosophical Society, Dec. 14.—**F. E. Weiss**: Some recent advances in our knowledge of inheritance in plants In the main, Mendel's work has been confirmed, but irregularities and exceptions have made subsidiary hypotheses necessary. The numerical ratios obtained by Mendel in the segregation of characters have been satisfactorily explained by the separation of the chromosomes in the reproductive cells, and Prof. Morgan and his collaborators in America have worked out a very complete theory of the actual distribution in the chromosome filaments of the material carriers or genes of the unit characters. Though Morgan's views have been generally adopted, they must still be regarded as open to criticism. Recently it has been shown that it is difficult to reconcile them with the fact that in different, closely allied species of Crepis the number of the chromosomes is different, yet without apparent loss of important characters. Variation in the number of chromosomes occurs in many plants. Certain giant races possess twice the number of the nuclear constituents, whereas in other cases varying numbers of chromosomes do not appear to have caused fundamental differences in the plant. Very variable genera such as Rosa, Rubus and Cratægus possess multiple numbers of chromosomes. Millardet's original discovery of complete inheritance in certain strawberry hybrids of all the characters of one of the parental plants, and an absence of subsequent segregation, has been confirmed, and occurs in a number of other plants. More attention will probably have to be paid in the future to the 'field' or environment in which the genes develop, and this may also throw some light on the conditions which produce changes of these genes and result in the formation of variations and mutations.

PARIS.

Academy of Sciences, Dec. 20.—**E. Goursat**: Some partial differential equations.—**Maurice Hamy**: Some experimental researches. A study of a method for evaluating the errors due to the eyepiece micrometer of meridian telescopes.—**L. de Launay**: The possible rôle of transmutations in geology. Outline of a theory concerning the formation of the chemical elements and their distribution on the earth.—**A. Desgrez, L. Lescœur, and Mlle. S. Manjean**: The influence of the ionic reaction on the decomposition of sulphide waters by a current of inert gas: hydrological applications. The effect on the rate of removal of hydrogen sulphide by a current of inert gas from a mineral water the pH of which has been changed by the addition of salts is shown in a series of curves.—**Benjamine Segre**: The generalisation of the transformation of Laplace.—**René Garnier**: Certain linear differential equations and the problem of Plateau.—**E. Vessiot**: Systems of equations and continuous transformations.—**Lainé**: An equation of the form $s = p\phi\ (x, y, z, q)$ integrable by the method of Darboux.—**Georges Valiron**: The values of the holomorph functions in a circle.—**Octave Onicescu**: The adjusting an ensemble of values.—**Paul Dumanois**: Concerning the use in internal combustion motors of slightly inflammable combustibles. A study of the conditions under which a petroleum product such as white spirit (boiling-point range 130°-180° C.) can be used in an aviation motor.—**P. Salet**: The constancy of the velocity of light. Reply to the criticisms of La Rosa on conclusions given in an earlier communication.—**P. Helbronner**: Results of the operations of the meridian chain of Corsica and of the junction of this with the islands of the Tuscan archipelago.—**Th. Vautier**: Forms and deformations of aerial waves.—**Pierre Bricout**: The value of the potential at the interior of a cluster of electrons in movement.—**G. Bruhat and M. Pauthenier**: The surface tension of insulating liquids submitted to the electric field. A thermodynamic proof that the surface tension of an insulating liquid is independent of the electric field.—**G. Colange**: The mechanism of the electrolytic interruptor. A description of a new type of electrolytic interruptor.—**A. Couder**: A new type of photographic telescope. An improvement of Schwarzschild's method, using two mirrors with a reflecting telescope.—**G. Vaugeois**: The influence of the nature of the support on the radon evolved — **Henri Belliot**: Photographic inversion by heat.—**E. Carrière and Ducasse**: Determination of boiling-point and dew-point curves of mixtures of hydriodic acid and water under a pressure of 746 mm. of mercury.—**Pierre Chevenard and Albert Portevin**: The influence of carbon and silicon on graphite formation in white cast irons. In the alloys studied the carbon varied from 1·7 per cent. to 4·5 per cent., the silicon from 0·2 per cent. to 6 per cent. The results are given in a three-dimension diagram, with silicon, carbon, and temperature of graphite formation as variables.—**H. Colin and Mlle. A. Chaudin**: The law of hydrolysis of saccharose by acids. A repetition of Wilhelmy's research with instruments of high precision on the inversion of sugar by acids (nitric acid, oxalic acid). The quantity $\frac{1}{t}\log\frac{a}{a-x}$ increased with time. From this it is concluded that the hydrolysis of sugar by dilute acids is not a simple monomolecular reaction, neither is it the resultant of two reactions one of which is instantaneous —**Mlle. Suzanne Veil**: The evolution of iron sulphide in contact with water. A study of the changes in the magnetisation coefficient of sulphide of iron produced by heating with water to various temperatures.—J. Cournot and Eugène Pérot: The cementation of aluminium by copper.—B. Bogitch: Concerning the granulation of scoria. In the process of granulating metals or slags by pouring the molten material into water, explosions are fairly frequent. These can be avoided or much reduced in number by taking certain precautions.—Charles Prévost: A closed cycle of reactions concerning some derivatives of erythrene.—Antonin Němec: The determination of the requirements of agricultural soils in phosphoric acid by the colorimetric method. The influence of lime and iron.—Ch. Brioux and J. Pien: The lime requirements of acid soils. Electrometric curves of saturation and the Hutchinson-MacLennan indices. Buffer action towards bases. Comparison of the results obtained by the Hutchinson-MacLennan calcium bicarbonate and electrometric methods showed good agreement. For soils of equal *p*H values, clay soils and soils containing much humus require more lime for neutralisation than light sandy soils.—Maurice Azéma: The mechanism of excretion in the Ascidiidæ.—Jacques Pellegrin: The disappearance of opposite fins in African fishes of the Clariineæ group.—Alphonse Labbe: An experimental phyletic line, Canthocampus ⟶ Cyclops.—Jean Jacques Trillat: The secondary action of the X-rays on micro-organisms. These experiments show the marked influence of the secondary radiations excited by the primary radiation on a metallic radiator placed near the micro-organisms. The bactericidal action is greater the higher the atomic number of the metal forming the radiator.—Henri Hérissey and J. Cheymol: The chemical composition of geine (geoside). The formula given is mainly based on the facts that hydrolysis with gease gives vicianose and eugenol in equal molecules, whilst hydrolysis with acids gives *d*-glucose, *l*-arabinose, and eugenol.—N. Bezssonoff: Is the antiscorbutic action due to two different substances?—J. Meunier and Mlle. G. Saint-Laurens: Human biliary calculi containing a high proportion of copper. Recent work has shown that the presence of copper in plant and animal tissues is fairly general, and its presence can now scarcely be regarded as accidental. The maximum amounts hitherto found are of the order of 60 mgm. per kilogram. The calculi examined contained 3 grams per kilogram.

Official Publications Received.

BRITISH AND COLONIAL.

Proceedings of the Edinburgh Mathematical Society. Vol. 44 (Session 1925–26), Part 2, December. Edited by Dr. T. M. Macrobert and Prof. H. W. Turnbull. Pp. 57-153+viii. (London: G. Bell and Sons, Ltd.) 6s. net.

Proceedings of the Geologists' Association. Vol. 37, Part 4, December 21st. Edited by A. K. Wells. Pp. 345-462+plates 17-29. (London: Edward Stanford, Ltd.) 5s.

Transactions of the Royal Scottish Arboricultural Society. Vol. 40, Part 2, October 26. Pp. 71-182+27-34. (Edinburgh: Douglas and Foulis.) 8s.

Catalogue of the Seventeenth Annual Exhibition of the Physical Society and the Optical Society, January 4th, 5th and 6th, 1927, Imperial College of Science and Technology, Imperial Institute Road, South Kensington. Pp. 128+xxiv. (London: Physical Society, Imperial College of Science.)

The Journal of the London Mathematical Society. Vol. 1, 1926. Pp. iv+272. (London: Francis Hodgson.)

The Optical Convention, 1926. Catalogue of Optical and General Scientific Instruments. Pp. x+326. (London: The Optical Convention, 1 Lowther Gardens.) 6s. net.

Proceedings of the Optical Convention, 1926. Part 1. Pp. x+491+v+26 plates. Part 2. Pp. viii+493-1051+v+23 plates. (London: The Optical Convention, 1 Lowther Gardens.) 60s. net.

Department of Agriculture, Federated Malay States and Straits Settlements. Bulletin No. 38: A Preliminary List of Food-Plants of some Malayan Insects. Compiled by B. A. R. Gater, from the Records obtained in the Entomological Laboratory from 1920 to 1926, by G. H. Corbett and B. A. R. Gater. Pp. xvii+95. (Kuala Lumpur.) 50 cents.

Journal of the Chemical Society: containing Papers communicated to the Society. December. Pp. viii+iv+2971-3243. (London: Gurney and Jackson.)

Catalogue of Indian Insects. Part 11: Brenthidæ. By Richard Kleine. Pp. xiii+60. (Calcutta: Government of India Central Publication Branch.) 1.2 rupees; 2s.

Bureau of Education, India. Occasional Reports, No. 13: Bilingualism (with Special Reference to Bengal). By Michael West. Pp. xiii+354. (Calcutta: Government of India Central Publication Branch.) 2.4 rupees; 4s.

Aeronautical Research Committee: Reports and Memoranda. No. 1016 (M. 36): Some Physico-Chemical Studies on the Effect of Sunlight on Cotton. By Dr. Guy Barr and Isabel H. Hadfield. (B.1.c. Fabrics-Aeroplanes. 61-63-68.—M.C. 132, T. 1961, T. 2184, T. 2341.) Pp. 22+9 plates. 1s. net. No. 1043 (Ae. 230). Photographs of the Flow round a Model Screw working in Water, especially in the 'Vortex Ring State.' By C. N. H. Lock and H. C. H. Townend. (A.3 d. Airscrews, 92.—T. 2273.) Pp. 5+8 plates. 9d. net. (London: H.M. Stationery Office.)

Annual Report on the Working of the Museum Department during 1925–26. Pp. xii. (Malta: Government Printing Office.)

FOREIGN.

U.S. Department of Agriculture: Bureau of Biological Survey. North American Fauna, No. 48: Voles of the Genus Phenacomys. 1: Revision of the Genus Phenacomys; 2. Life History of the Red Tree Mouse (Phenacomys Longicaudus). By A. Brazier Howell. Pp. iv+66+7 plates. (Washington, D.C.: Government Printing Office.) 20 cents.

Annual Report of the Meteorological Observatory of the Government-General of Tyôsen for the Year 1923. Compiled by the Meteorological Observatory of the Government-General of Tyôsen. Pp. iv+156. (Zinsen.)

The Memoirs of the Imperial Marine Observatory, Kobe, Japan. Vol. 3, No. 1: An Attempt to Detect a Direct Effect of the Solar Activity on the Air Temperature at some Stations in the Central Part of Japan. By Rikiti Sekiguti. Pp. 21+7 plates. (Kobe.)

Proceedings of the Imperial Academy. Vol. 2, No. 8, October. Pp. xviii-xxiv+391-458. (Ueno Park, Tokyo.)

U.S. Department of Agriculture. Farmers' Bulletin No. 1495: Insect Enemies of the Flower Garden. By C. A. Weigel and William Middleton. Pp. ii+54. (Washington, D.C.: Government Printing Office.) 15 cents.

Department of Commerce: Bureau of Standards. Miscellaneous Publications, No. 75: Annual Report of the Director of the Bureau of Standards to the Secretary of Commerce for the Fiscal Year ended June 30, 1926. Pp. iv+45+2. (Washington, D.C.: Government Printing Office.) 5 cents.

Proceedings of the United States National Museum. Vol. 69, Art. 4: The Collection of Ancient Oriental Seals in the United States National Museum. By I. M. Casanowicz. (No. 2630.) Pp. 23+20 plates. Vol. 69, Art. 7: Descriptions of New Reared Parasitic Hymenoptera and some Notes on Synonymy. By C. F. W. Muesebeck. (No. 2633.) Pp. 18. Vol. 69, Art. 9: Review of the American Xylotine Syrphid-Flies. By Raymond C. Shannon. (No. 2635.) Pp. 52. Vol. 69, Art. 11. The Chrysotoxine Syrphid-Flies. By Raymond C. Shannon. (No. 2637.) Pp. 20. Vol. 69, Art. 14: American Two-Winged Flies of the Genus Microphthalma Macquart, with Notes on Related Forms. By J. M. Aldrich. (No. 2640.) Pp. 8. Vol. 69, Art. 15: Polychaetous Annelids from Fiji, Samoa, China and Japan. By A. L. Treadwell. (No. 2641.) Pp. 20+2 plates. Vol. 69, Art. 16: Identity of Hallowell's Snake Genera Megalops and Aspidura. By Leonard Stejneger. (No. 2642.) Pp. 2. Vol. 70, Art. 2. Descriptions of Larvae and Pupae of Two-Winged Flies belonging to the Family Leptidae. By Charles T. Greene. (No. 2651.) Pp. 20+8 plates. Vol. 70, Art. 3: A Fossil Palm Fruit from the Middle Eocene of Northwestern Peru. By Edward W. Berry. (No. 2652.) Pp. 4+1 plate. Vol. 70, Art. 5: A Collection of Birds from the Provinces of Yunnan and Szechwan, China, made for the National Geographic Society by Dr. Joseph F. Rock. By J. H. Riley. (No. 2654.) Pp. 70. Vol. 70, Art. 6: Nematode Eggs from the Gill Region of a Shark Carcharhinus Milberti. By G. A. MacCallum. (No. 2655.) Pp. 2. (Washington, D.C.: Government Printing Office.)

CATALOGUES.

The Francis Lamp Lock. Pp. 4. (London: Francis Lamp Locks, Ltd.)

Microscope Record. No. 10, January. Pp. 32. (London: W. Watson and Sons, Ltd.)

Diary of Societies.

SATURDAY, JANUARY 29.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Neville Hall, Newcastle-upon-Tyne), at 3.—P. F. Hope: Steam and Electric Locomotives for Colliery Purposes.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. E. W. Tristram: English Medieval Wall-Painting (2).

INSTITUTE OF BRITISH FOUNDRYMEN (Birmingham, Coventry, and West Midlands Branch) (at Engineers' Club, Birmingham), at 6.30.—T. Teisen: Modern Gas-Fired Annealing and Other Furnaces.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE.—Sir W. Larke: Steel Commercially Considered.

MONDAY, JANUARY 31.

CAMBRIDGE PHILOSOPHICAL SOCIETY (at Cavendish Laboratory, Cambridge), at 4.30.—Sir Joseph Larmor: What Determines the Resistance and Tilt of an Aeroplane?—L. H. Thomas: The Effect of the Orbital Velocity of the Electrons in Heavy Atoms on their Stopping of α Particles.—Dr. F. H. Constable: Surface Adsorption and the Velocity of Chemical Action at Gas-Solid Interfaces.—H. D. Ursell: The Evaluation of Gibbs' Phase Integral for Imperfect Gases.—*To be communicated by title only*:—Prof. G. H. Hardy: Note on Ramanujan's Arithmetical Function $\tau(n)$.—Prof. G. H. Hardy and J. E. Littlewood: Notes on the Theory of Series (iv.): On the Summability of the Fourier Series of a Nearly Continuous Function.—R. Vaidyanathaswamy: The Pedal (3, 2) Correspondence.—W. Hunter: Lines and Planes in a Metrical Space.

Institute of Actuaries, at 5.—V. P. A. Derrick: Observations on (1) Errors of Age in the Population Statistics of England and Wales, and (2) the Changes in Mortality indicated by the National Records.

Royal Society of Arts, at 8.—Dr. L. C. Martin: Recent Progress in Optics (Cantor Lectures) (3).

Royal Institute of British Architects, at 8.30.—Presidential Address to Students and Presentation of Prizes.

TUESDAY, February 1.

Royal Institution of Great Britain, at 5.15.—Prof. J. S. Huxley: Problems of Animal Growth and Development (1).

Institution of Automobile Engineers (jointly with Royal Aeronautical Society) (at Royal Society of Arts), at 7.—A. H. R. Fedden: The Supercharging of Aero Engines.

Institute of Metals (Birmingham Section) (at Engineers' Club, Birmingham), at 7.—Dr. G. D. Bengough: Corrosion.

Royal Photographic Society of Great Britain, at 7.—T. H. B. Scott: Presidential Address.

Institute of Metals (North-East Coast Section) (at Armstrong College, Newcastle-upon-Tyne), at 7.30.—C. E. Pearson: Methods of Measuring Temperatures.

WEDNESDAY, February 2.

Institution of Mining Engineers (Annual General Meeting) (at Institution of Mechanical Engineers), at 11 a.m.—H. E. Mitton: Miners' Dwelling-houses.—The Haulage of Men Underground. Report of a Committee of the South Yorkshire Coal Trade Association.—R. Clive: The Occurrence of Gas.—A. D. Brydon: Surveying Boreholes by the Briggs 'Clinophone' and 'Clinoscope.'—J. P. Rees: The Effect of Ventilation on the Cooling Power of the Air (Eleventh Report to the Committee on 'The Control of Atmospheric Conditions in Hot and Deep Mines').—Dr. J. S. Haldane: (a) The Maximum Efficiency of Heat-engines, and the Future of Coal and Steam as Motive Agents; (b) The Thermal Efficiency of a Carnot Engine.—At 2.30.—Dr. W. Hancock: (a) A New Hygrometer for Mines; (b) Local Air-conditioning Underground by Means of Refrigeration (Twelfth Report to the Committee on 'The Control of Atmospheric Conditions in Hot and Deep Mines').

Geological Society of London, at 5.30.—Prof. V. C. Illing: The Geology of the Naparima Region of Trinidad.—Dr. W. L. F. Nuttall: Tertiary Foraminifera from the Naparima Region of Trinidad.

Royal Society of Medicine (Tropical, Dermatology, and Therapeutics Sections), at 5.30.—Special Discussion on The Treatment of Leprosy.

Institution of Electrical Engineers (Wireless Section), at 6.—C. F. Phillips and others: Informal Discussion on The Purpose and Design of Broadcast Receivers.

Institution of Civil Engineers (Students' Meeting), at 6.30.—J. L. Hunt: Escalator Tunnels and other Works at Piccadilly Circus.

North-East Coast Institution of Engineers and Shipbuilders (Graduate Section) (at Bolbec Hall, Newcastle-upon-Tyne), at 7.15.

North-East Coast Institution of Engineers and Shipbuilders (Middlesbrough Branch, Graduate Section) (at Middlesbrough), at 7.30.—J. L. Taylor: Oil Tankers.

Royal Society of Arts, at 8.—N. Evers: Chemistry and the Supply of Drugs.

Society of Public Analysts and other Analytical Chemists (at Chemical Society), at 8.—T. H. Barry: Arsenic in Printing Inks.—G. D. Elsdon and J. R. Stubbs: The Immersion Refractometer and its Value in the Analysis of Milk.—Dr. P. Haas and Barbara Russell-Wells: Irish Moss Mucilage and a Method for its Determination.

Eugenics Society, at 8.

THURSDAY, February 3.

Royal Society, at 4.30.—Prof. W. A. Bone and A. Forshaw: Studies upon Catalytic Combustion. V. The Union of Carbonic Oxide and other Gases with Oxygen in Contact with a Fireclay Surface at 5000° C.—A. Egerton and S. F. Gates: (a) On Detonation of Gaseous Mixtures of Acetylene and Pentane; (b) On Detonation of Gaseous Mixtures at High Initial Pressures and Temperatures.—M. W. Garrett: Experiments to Test the Possibility of Transmutation by Electronic Bombardment.—F. C. Lay, W. Ll. Prichard, and J. A. Sutcliffe: The Latent Heat of Vaporisation of Benzene at Temperatures above the Boiling Point.—H. A. Fells and J. B. Firth: (a) The Function of Water present in Silicic Acid Gel. The Structure of Silicic Acid Gel, Part II.; (b) The Phenomena arising from the Addition of Hydrogen Peroxide to Silicic Acid Gel.—E. Newbery: Anodic Overvoltage Measurements with the Cathode Ray Oscillograph.—C. Cuthbertson: (a) Absorption of Radiation in the Extreme Ultra-violet by the Inert Gases; (b) On a Relation between the Refractive and Dispersive Constants of the Inert Gases.—Prof. C. V. Raman and K. S. Krishnan: The Diffraction of Light by Metallic Screens.—R. G. Fraser: The Effective Cross Section of the Oriented Hydrogen Atom.—Sir Richard Paget: The Nature and Artificial Production of the, so-called, Voiced and Unvoiced Consonants.—L. Pauling: The Theoretical Prediction of the Physical Properties of Many-Electron Atoms and Ions.—B. F. J. Schonland and J. Craib: The Electric Fields of South African Thunderstorms.—Prof. J. C. McLennan, J. H. McLeod, and W. C. McQuarrie: An Investigation into the Nature and Occurrence of the Auroral Green Line λ 5577 A.—Sir Almroth Wright: A Further Contribution to the Study of the Phenomena of Interaction.

Royal Institution of Great Britain, at 5.15.—Sir William Bragg: Acoustical Problems treated by Lord Rayleigh: (1) Æolian Tones.

Institution of Electrical Engineers, at 6.—Lt.-Col. K. Edgcumbe and F. E. J. Ockenden: Some Recent Advances in Alternating-Current Measuring Instruments.

Society of Chemical Industry (Chemical Engineering Group) (jointly with Bristol and Fuel Sections) (at Bristol University), at 7.30.—J. W. Reber and M. Scott: Production of Power from Towns' Refuse.

Chemical Society, at 8.—J. W. Baker and Dr. C. K. Ingold: The Nature of the Alternating Effect in Carbon Chains. Part XIV. The Directive Action of Some Groups of the Form $-CR'R''.CO.R$ in Aromatic Substitution.—J. W. Baker and L. S. Wilson: The Nature of the Alternating Effect in Carbon Chains. Part XVII. The Directive Action of the Groups $.CH_2.CH_2.NO_2$, $.CH:CH.NO_2$ and $.C(NO_2):CHR$ in Aromatic Substitution.—A. Ferguson and I. Vogel: (a) The Storch Equation, a General Dilution Formula and the Validity of the Law of Mass Action at Limiting Dilutions; (b) The Calculation of the Equivalent Conductivity of Aqueous Solutions of Strong Electrolytes at Infinite Dilution. Part II. Application to Data at 0°, 18°, and 25° C.; (c) The Calculation of the Equivalent Conductivity of Aqueous Solutions of Strong Electrolytes at Infinite Dilution. Part III. The Mobilities of the Hydrogen and the Hydroxyl Ions.

Röntgen Society (at British Institute of Radiology), at 8.15.—Dr. J. M. W. Morison: New Radiological Department, the Royal Infirmary, Edinburgh.—H. D. Griffith: The Physics of Carbon Arc Therapy.

Institution of Mechanical Engineers (Glasgow Branch).—Prof. A. L. Mellanby and Prof. W. Kerr: Use and Economy of High Pressures in Steam Plant.

Institution of Mechanical Engineers (Manchester Branch).—E. W. Tipple: Machine Tools.

FRIDAY, February 4.

Royal Society of Medicine (Laryngology Section), at 5.

Geologists' Association (Annual General Meeting) (at University College), at 7.—Presidential Address: Some Aspects of the Mountain Building Problem.

Society of Chemical Industry (Manchester Section, jointly with Manchester Section of Oil and Colour Chemists' Association) (at 16 St. Mary's Parsonage, Manchester), at 7.—C. W. Gamble: The Constants of Colour—Hue, Purity, and Luminosity.

Institution of Mechanical Engineers (Informal Meeting), at 7.—W. Reavell: Engineering Salesmanship.

Royal Photographic Society of Great Britain (Pictorial Group), at 7.—W. L. F. Wastell: Psychology and the Print.

Photomicrographic Society (at 4 Fetter Lane), at 7.—H. Wrighton: The Photomicrography of Metals.

Junior Institution of Engineers, at 7.30.—P. R. Jackson: The Theory of the Gyroscopic Compass.

Philological Society (at University College), at 8.—Prof. E. Weekley: Romance Notes.

Royal Institution of Great Britain, at 9.—Prof. E. V. Appleton: Wireless Transmission and the Upper Atmosphere.

Oxford University Junior Scientific Club.—Speaker—Mr. Hodges.

SATURDAY, February 5.

Royal Society of Medicine (Otology Section), at 10.30 a.m.—Dr. C. P. Symonds: Cerebral Abscess; Some Points in Diagnosis and Localisation.—Dr. Farquhar Buzzard: The Treatment of Traumatic Facial Paralysis.

Royal Institution of Great Britain, at 3.—W. de la Mare: Craftsmanship in Verse.

PUBLIC LECTURES.

SATURDAY, January 29.

Horniman Museum (Forest Hill), at 3.30.—Miss M. A. Murray: Some Invasions of Ancient Egypt.

SUNDAY, January 30.

Guildhouse (Eccleston Square), at 3.30.—Rabbi Dr. I. Mattuck: The Soul of Judaism.

MONDAY, January 31.

King's College for Women (Household and Social Science Department), at 5.15.—F. Hodges: The Future of the Mining Industry.

TUESDAY, February 1.

Bedford College for Women, at 5.15.—Sir Thomas L. Heath: Conceptions of the Cosmos in the Classical Period.

University of Birmingham.—Prof. G. Elliot Smith: Science and Culture (Huxley Lecture).

WEDNESDAY, February 2.

King's College, at 5.30.—Dr. O. Vočadlo: The Wends: The Ancient Slavonic Inhabitants of Northern Germany.

University College, at 5.30.—Major W. E. Simnett: Special Libraries.—At 6.—Prof. A. L. Bowley: Tests of the Trustworthiness of Public Statistics (Newmarch Lectures) (1).

THURSDAY, February 3.

King's College, at 5.30.—Dr. J. A. Hadfield: The Mind: Psychotherapy.

Northampton Polytechnic Institute, at 7.—R. Genders: Steel and its Thermal Treatment: Engineering and other Special Steels.

Royal Society of Arts, at 8.—Prof. C. H. Reilly: Developments in Building Methods (Chadwick Public Lecture).

Fulham Public Library, at 8.—Dr. J. R. Leeson: The Infinitely Small and the Infinitely Great: The Structure of the Universe from the Electron to the Nebula.

FRIDAY, February 4.

London School of Economics, at 5.—F. Debenham: The Economic Aspects of the Polar Regions. (Succeeding Lectures on February 11 and 18.)

SATURDAY, February 5.

Horniman Museum (Forest Hill), at 3.30.—V. Gordon Childe: The Aryans, our Linguistic Ancestors.

SUNDAY, February 6.

Guildhouse (Eccleston Square), at 3.30.—Maulvi A. R. Dard: The Soul of Islam.

SATURDAY, FEBRUARY 5, 1927.

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No. 2988, VOL. 119]

Education of the Adolescent.[1]

TO form and to strengthen character; to train tastes which will dignify leisure; to awaken and guide intelligence, especially on its practical side: these are the three ends which the Consultative Committee of the Board of Education had in mind when framing the recommendations which have been embodied in its Report on the Education of the Adolescent, and, even though we may have some difficulty in discovering the exact dividing line between the qualities of the second and third, we must admit that they are ends which, if attained, would make formal education almost as vital to human life and activity as nutrition and reproduction.

There are, of course, many forces which operate against the attainment of such ends, and not the least is the attitude of mind of the very committees which make such valuable recommendations. Let there be no mistake: if, as we shall attempt to show later, the present Committee has not been infallible, there can nevertheless be no doubt that it has faced its problems with unusual breadth and clarity of vision. It has faced boldly—whether the revision and extension of school nomenclature it suggests receive approval or not—the inevitability of a regrading of education, and it has not lacked the courage to recommend the raising of the school leaving age. It has left no avenue unexplored, and it has neglected no statistical detail in order that, so far as it could see them, no factors of the present system should be avoided in its argument. Not forgetting that "a community must solve its . . . problems in accordance with its own traditions and customs," the Committee has carefully examined the history which has brought these factors into being, and has lucidly set forth the lines of advance which it believes will lead to a system capable of securing for its pupils the benefits we have described. Nor has it shirked the issue of demonstrating how its recommendations may be made administratively possible.

These points, in themselves, are perhaps sufficient to demonstrate with what sense of responsibility the Committee regarded terms of reference which not only requested attention to the organisation, objective, and curriculum of courses of study for children (other than those attending secondary schools) who will remain in full-time school attendance up to the age of fifteen, but also that regard should be had to their probable future occupations in commerce, industry, and agriculture—a feature which led the Committee at an early stage in its report to make a pronouncement so important that we need not apologise for its reproduction: "The educationalist, unless he would build his castles in the air, is bound at every turn to take into account the probable future of the children and the nature of the industrial society into which . . . the majority will enter." Or, again: "School and industry are different facets of a single society, and the habit of mind which isolates them is a habit to be overcome."

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[1] Board of Education. Report of the Consultative Committee on the Education of the Adolescent. Pp. xxiv+339. (London: H.M. Stationery Office, 1926.) Paper, 2s. net; cloth, 3s. net.

Reading that, the technical teacher might well begin to congratulate himself that, at last, the liberal quality, as well as the importance of his work, was being recognised; and he would be strengthened in his view when he read, further, a recommendation which begins: "A humane and liberal education is not one given through books alone, but one which brings children into contact with the larger interests of mankind." If he read still further, however, he would discover that the Committee is discussing the proposed 'Modern' (at present 'Central') Schools, and that when it realises whither the argument may lead, seems to become suddenly fearful and is careful to point out that it is *not* suggesting any wide extension of Junior Technical Schools, but that the 'modern' school should develop with a 'realistic' or 'practical' bias and should not aim "at giving a technical or vocational education." He would see that the Committee's attitude towards technical education is one which fits but ill with the philosophical statements which preceded his search. A little puzzled, he would turn to the Committee's definition of this word 'bias,' and find his dilemma still further increased. Finally, he would lose the last vestige of his optimism when he discovered the Committee's view that a foreign language is regarded as necessary in the modern school, but its necessity in the Junior Technical Schools —even though its lack may be a barrier against matriculation and entry into the learned institutions—is set out in very guarded terms. He will not, therefore, be very much to blame if he thinks the work of technical education is still but little understood, and that the ancient and arid arguments between the values of 'arts' and 'sciences,' and between 'pure' and 'applied' science are not yet at an end. A crumb of comfort will fall to him, however, when he reads that, on suggested examination boards, "Technological teachers might be co-opted."

If, in its view and knowledge of the work of technical schools, the Committee has not been infallible, it is beyond doubt that it has been very largely influenced by the inevitable trend towards the linking up of education and industry. It has not failed to observe that the modern development of industry has resulted in a loss of craftsmanship and an increase in leisure, due to the lessening hours of labour, and it has therefore rightly regarded the school as an instrument which can do much to counteract the loss of craftsmanship and to secure that leisure may be wisely used. In this connexion it has laid some stress upon handwork, and, in addition, to recommending that a sufficient number of teachers must have the craftsman's interest and outlook; it has given evidence of its recognition of another important question by its suggestion that girls as well as boys should learn something of the use of tools, and should be allowed to take a short course in wood and metal work.

There is not, perhaps, much that is new in the Committee's suggestions on the teaching of science. The interdependence of the various subjects is clearly indicated. Not only is the science teacher to keep closely in touch with the teachers of drawing and mathematics, but also "simple apparatus might be made by pupils in wood and metal lessons." In the case of girls, the science courses of the Modern Schools should, in their later stages, have a biological trend; and the work should not, as is frequently the case, be confined to botany. The reasons given for this recommendation show that the Committee has taken care that the liberal qualities of science teaching shall be thoroughly understood, and that it shall not aim at the assimilation of unrelated facts. "The study of simple forms of animal life can . . . be made an admirable means of widening and disciplining the pupils' sympathies" and will increase happiness and efficiency. In the same way, for boys and girls, instruction in biology and elementary physiology "might well provide the basis for a right attitude to many social problems." To the initiated these suggestions may form part of an accepted philosophical attitude towards education—especially on its scientific side—which is almost a *sine qua non* of a rapidly developing society. For our part we welcome them, since we do not lack evidence that words and actions are often poles apart, and we realise that there cannot be too much examination and repetition of fundamentals.

If post-primary education is to be a unity in the full sense of that word, we may be pardoned if we refer to a subject sometimes (wrongly) regarded as outside our province. In dealing with the teaching of history, the Committee has dealt well with the view that it is a study of the organised life of a community, and has regarded part of its function as the enabling of the pupil to see the present as a development of the past. On our side we are tempted to regard the present as but a thin dividing line between the past and future. Doubtless the Committee holds the same view, but until the science section of the Report is reached we do not observe any suggestions which would mean the presentation of any historical view of what science has done for mankind. In these days of the cinema, aircraft, wireless telephony and broadcasting, it seems to us an essential part of a liberal education that the influence of science in breaking down the barriers of space, and in drawing together people who formerly were antagonistic because of their lack of mutual understanding, should have some definite part in the most formal teaching of history.

We willingly run the risk of being told that we are not aware of the correct place of such teaching. For the moment we regard it as sufficient that the point be made, and, while waiting for the later pronouncements upon such an important theme, we may leave it quite safely in the hands of the teachers of science.

Modern Occultism.

Der physikalische Mediumismus. Von Dr. W. v. Gulat-Wellenburg, Graf Carl v. Klinckowstroem und Dr. Hans Rosenbusch. ("Der Okkultismus in Urkunden," herausgegeben von Max Dessoir.) Pp. xiv + 494 + 15 Tafeln. (Berlin: Verlag Ullstein, 1925.)

THIS imposing volume is known in Germany and Austria as the "Dreimännerbuch." It is the first of a trio of books intended to deal exhaustively with modern representatives of those 'occult sciences' which have never ceased to occupy a certain type of mind since the days of Paracelsus. The increasing habit of civilised humanity to submit all such 'hidden' sources of knowledge to examination by modern scientific methods has driven their advocates and devotees to adopt at least an apparently up-to-date terminology.

Thus we do not hear much about the Secret Rose, the Elixir of Life, or the Fifth Essence. But we are told all the more about Psychophysical Energy, Metapsychics, Rigid Rays, Telekinesis, and Ectoplasia—imposing words which to many minds convey an irresistible suggestion of reality.

It would of course be impossible to deal in one book with the vast volume of occult literature, nor do the 'three men' make any attempt to do so. But they do pass in review what may be called the serious treatments of the subject, and the sporadic attempts to apply some scientific method to the study of alleged phenomena which seem to contradict well-known physical and biological laws.

Of the three authors of this book, Count von Klinckowstroem deals with the "Confessions of a Medium" as well as classical mediums like D. D. Home, Florence Cook, Slade, Guzik, and Mrs. Gilbert. Dr. Rosenbusch studies Eusapia Paladino, Stanislava Tomczyk, and Kathleen Goligher, while Dr. von Gulat-Wellenburg examines the claims of Marthe Béraud ('Eva C.'), Franck Kluski, Willy Schneider, Nielsen, and Laszlo.

It may seem a deplorable waste of time and energy to devote five hundred pages of close print to the criticism of alleged phenomena which have been almost unanimously rejected by the scientific world. But it is necessary to remember that we are here dealing with alleged happenings which, if authenticated, would necessarily change our whole outlook on the possibilities of life and even of non-living matter. Even in their unproven state these alleged observations are exerting a very wide influence on great masses of contemporary thought and feeling. To millions they form the basis of a new religion purporting to have a sound scientific basis. One cannot envy the fate of the few leaders of science whose names are perennially quoted as supporting and sanctioning spiritualist practices. The name most widely exploited in this connexion is that of the late Sir William Crookes, whose few experiments, undertaken without appropriate training and then abandoned, have formed a peerless model for all later investigators and imitators.

The truth appears to be that these 'supernormal' phenomena bring us face to face, not so much with a higher world of spirit as with an underworld of human credulity, based upon an irresistible appetite for the marvellous. This appetite or need has always existed; and it has always rebelled against the established order of things. It has always postulated the existence of beings superior to it, whether angels or jinns or the spirits of the dead. Who can wonder that men trained in scientific methods have sometimes shown a similar weakness! Physicists show this tendency perhaps more than others. But that may be due to the fact that their researches are the most fundamental as regards the structure of the universe. They work on the very frontier of the unknown, and their recent discoveries are so marvellous that a miracle more or less does not seem to signify.

The modern attempt to erect occultism into a science was supported, if not initiated, by Alexander Aksakof, whose "Animism and Spiritism" advocated the view that spiritistic phenomena were not due to disembodied intelligences but to unexplained powers of the human organism itself. It was he who coined the word 'telekinesis' for movement without contact, and one cannot help wondering how many conjuring tricks, clever or otherwise, have since been dignified by that beautifully fashioned Greek word. It was Dr. Ochorowick who invented 'ectoplasy,' though it did not become popular until F. W. H. Myers defined it in his work on "Human Personality and its Survival of Bodily Death." He called it "the power of forming outside some special organism a collection or reservoir of vital force or of vitalised matter which may or may not be visible or tangible but which operates in like fashion as the visible and tangible body from whence it is drawn."

Many attempts have been made to investigate this mysterious 'vitalised matter' and to define its properties. If we were to take the current spiritualist view, ectoplasy, or rather 'ectoplasm,' would be the substratum of all 'materialisations,' even of full figures like Crookes's Katie King, *plus* her calico dress. It would also constitute the 'rigid rays' emanating from the fingers of Mlle. Tomczyk, the 'psychic rods' of the Goligher circle, and the plastic structures described by Dr. v. Schrenck-Notzing. The latter were supposed to consist of amorphous material capable of assuming any form or appearance suggested by the medium's subconscious mentality. Thus they sometimes showed the structure of half-formed faces in plaster-of-Paris, which were ascribed to the frequent visits of the medium to a sculpture studio.

According to Schrenck-Notzing the ectoplastic structures are very sensitive to illumination and to touch. 'Katie King,' in Crookes's charmed circle, could cut off strips of her dress, and materialise them permanently enough to be examined in daylight. But ordinarily the material is fugitive in light, and contact is not allowed for fear of injuring the medium.

Here again it is difficult to arrive at any sort of consistency. Dr. Crawford was allowed to touch a 'psychic rod.' It felt like a stockinged foot, with toes complete, but the medium was neither hurt nor injured by the touch. Also, did not v. Schrenck-Notzing himself take a kinematograph picture of a materialisation without inflicting any injury ?

A biologist inclined to credit the existence of ectoplasm endeavoured some time ago to form some intelligible conception of it by supposing it to partake of the nature of pseudopods put out by unicellular organisms. But this would scarcely account for Katie King's obviously woven calico. The late Dr. Crawford's speculations concerning 'X' and 'Y' matter building up 'psychic rods' capable of lifting tables and adhering to carmine and other pigments cannot be taken seriously, in view of the total absence of scientific control of the Goligher circle. Nobody has as yet put forward a description of 'ectoplasm' which will cover the various forms of its alleged occurrence or permit of any consistent theory as to its properties. Even the assertion that it emanates from the epithelium of any natural orifice of the organism fails to cover cases where it is alleged to emanate from the fingers. The analysis of a fragment of the substance said to have been isolated by Dr. v. Schrenck-Notzing showed nothing but epidermis such as might have been peeled off a human heel.

The authors of the "Dreimännerbuch" must be congratulated on the minute and serious analysis of all 'supernormal' phenomena which have been vouched for by persons of any scientific standing. Their criticism is objective and temperate, and in all cases where a normal explanation is difficult or impossible they frankly admit its being so. One is therefore inclined to give all the more weight to their main conclusion, which is that the scientific proof of the reality of physical mediumistic phenomena has never yet been furnished, all the alleged phenomena being capable of a normal explanation based upon deception or inadequate observation. The only cases which they are inclined to leave in doubt are certain reports concerning D. D. Home and a few experiments with Eusapia Paladino. But even these are now of little value owing to the impossibility of repetition.

That the phenomena in question are rare and elusive does not in itself deprive them of scientific interest. But it is becoming increasingly clear that any hope of their substantiation depends upon the provision of competent observers. The qualifications of such observers must be very high, much higher than in the case of ordinary physical and biological investigations. Not only must the psychic researcher be acquainted with all the abnormalities of vision in a feeble light and under prolonged strain, but he must also be versed in the numberless possibilities of deliberate deception and trickery. The ordinary physicist or biologist is quite incapable, as a rule, of explaining a clever conjuring trick performed in a bright light. Yet he will sometimes assert that all possibility of fraud was excluded in circumstances which would make a conjurer smile.

No new observations can in future be taken seriously unless the observer shows a close acquaintance with the sources of error involved in these investigations. In this respect the "Dreimännerbuch" furnishes a valuable test of knowledge. Considering that the English-speaking world is more obsessed by spiritualism than the rest of civilised mankind, an English translation of this book would fill an important place by the side of Myers and Podmore.

German Handbooks of Physics.

1) *Handbuch der Experimentalphysik*. Herausgegeben von W. Wien und F. Harms. Band 2: ***Mechanik der Massenpunkte und der Starren Körper***. Von Prof. Dr. Arthur Haas. Pp. xiv + 355. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1926.) 30 gold marks.

2) *Handbuch der Physik*. Herausgegeben von H. Geiger und Karl Scheel. Band 1: *Geschichte der Physik; Vorlesungstechnik*. Redigiert von Karl Scheel. Pp. vi + 404. (Berlin: Julius Springer, 1926.) 31·50 gold marks.

THE progress of physics during the last few decades has been truly remarkable, and it is with a feeling akin to hopelessness that the present-day physicist vainly attempts to keep abreast of the times. As the science has developed, specialisation has become more and more necessary, and it is to this intensive specialisation that physics owes its present vastness. In such circumstances, the need for an up-to-date "Handbook of Physics" for purposes of reference has become increasingly urgent, and it was to be expected that sooner or later such a work would be forthcoming. In English, the "Dictionary of Applied Physics" serves a useful purpose in enabling physicists to have easy access to recent developments in the divers branches of their subject, and in German, apart from several excellent handbooks on special branches, Winkelmann's "Handbuch" has done valuable service, though it is now somewhat out-of-date.

The deficiency is now being rectified, and there are at present in course of publication two distinct 'handbooks' of physics. One of these, the "Handbook of Experimental Physics," is being edited by Wien and Harms. Its aim is to give a detailed presentation of modern physics and geophysics from the experimental viewpoint, and to introduce only that minimum amount of theory necessary for the intelligibility of the actual facts, in view of the tendency of modern theory to age as fresh experimental material accumulates. For obvious reasons of uniformity, the number of contributors to the work has been kept as low as is consistent with an authoritative treatment of the various branches of the subject. Geiger and Scheel are primarily responsible for the editing of the other "Handbook of Physics." The number of contributors is larger than in the work of Wien and Harms, and the scope of the 'handbook' is more comprehensive, for it aims at giving a complete survey of the current position of theoretical as well as of experimental physics.

The list of distinguished scientific workers contributing to these two 'handbooks' is a guarantee of the excellence of the finished products. Nevertheless, one cannot suppress a feeling of regret at the publication simultaneously of *two* monumental works, the expressed aims of which are so similar. Surely one such work would have sufficed to fill the gap in current literature. Each 'handbook' is to comprise some twenty or more volumes, at a total cost of anything from forty to sixty pounds. Few private individuals can afford such an outlay for a comprehensive work on physics, and whereas most scientific libraries will endeavour to procure one or other of the handbooks, it is equally certain that they will be unable to procure both. The volumes can, however, be obtained separately.

(1) Vol. 2 of the Wien-Harms 'handbook' is entitled "The Mechanics of Particles and of Rigid Bodies." This is probably the most difficult of the various branches to bring within the scope of a handbook of experimental physics, for in it experiment plays a much less predominant part than in other branches of physics, and it has reached such a state of development that it has fewer fundamental advances to record than have other departments of the subject. For this reason, and we believe wisely, Prof. Haas has departed from the acknowledged form of 'handbooks,' usually so full of detailed references to the literature, and the result is very pleasing.

The book is divided into three parts, the first dealing with the motion of a particle, the second with the mechanics of a rigid body, and the third being devoted to the mathematical treatment of the mechanics of rigid bodies. The first two parts are comprehensive, but essentially elementary in their mode of treatment, and only the most important results of theory are presented, in so far as they are of importance in experimental physics. The experimental foundations of the theory and the comparison of the results of theory and experiment are discussed, and particular attention is given to mechanical problems which are important in the physics of measurement. The mathematical development of the subject has been intentionally relegated to the third part of the volume, so as to simplify the task of the less mathematical reader.

In accuracy of thought, logical development, and clearness of expression, the author is a master, and it would be difficult to imagine a more admirable treatment of the fundamental conceptions of kinematics than we find in the opening chapter of the book. Equally good are the chapters on pendular motion, processes of motion on the rotating earth, celestial mechanics, and gyroscopic motion, to mention but a few.

Free use of vector notation is made in the third and essentially mathematical part of the book. As the various results are derived, the appropriate references to the earlier non-mathematical sections of the text are given. This last section of the volume is perhaps the most valuable of all, for the treatment, though brief, is masterful, and contains all the essential steps in the development of the numerous results.

The book is attractively produced, and contains more than two hundred illustrations, carefully done, which add greatly to its clearness. The volume concludes with a list of references to recent literature on the experimental aspects of such topics as general and terrestrial gravitation, gyroscopic phenomena, and friction between solid bodies.

We have learned from experience to expect something good from Prof. Haas, and once again we are not disappointed.

(2) Vol. 1 of the Geiger-Scheel 'handbook' is devoted to the history of physics and to the technique of lecture experiments. It comprises four chapters—rather an odd term, in view of the fact that the second and third chapters together occupy only twenty-eight of the four hundred pages in the book.

The history of physics (Chap. i.) has been admirably written by an acknowledged authority on the subject, Prof. Hoppe of Göttingen. In one hundred and eighty pages we are provided with a fascinating account of the progress of physical science from Babylonian times up to the year 1895. The first section deals with the contributions of the Babylonians, the Egyptians, the Greeks, and the Arabians, and concludes with a review of scientific advance in Christian Europe as fa as the year 1600. At this point was initiated period of sound progress, when men like Keple and Newton placed the subject on an exact basis and freed it from methods of idle speculation whic all too frequently characterised the work of thos who preceded them. The second section of th chapter is concerned with this period of intensiv growth, and brings us to the year 1842. In th third and final section, which ends with the yea 1895, we pass in review the work of Kelvin Helmholtz, Maxwell, and their contemporaries, an are led from classical physics to the fringe of moder atomic physics, for the chapter concludes wit the discovery of radium and polonium. Detaile references are to be found on almost every page This interesting account of the development physics through the ages arouses feelings of regre that more time is not devoted, in academic course to the history of physics. Text-book physics ofte tends to give us a wrong sense of perspective i the development of the subject, for it has frequentl happened that great advances have been stimulate by the use of hypotheses accepted at the tim but later shown to be untenable. Prof. Hoppe ha endeavoured to give a balanced treatment of th growth of physical knowledge, and to place th historical evidence in its right perspective; th result makes informative and instructive reading.

Prof. Scheel contributes a brief but interestin account (Chap. ii.) of the development of th research literature of physics, commencing wit the *Philosophical Transactions of the Royal Society* which first appeared in 1665, and ending with th "International Critical Tables" of the Nation Academy of Science and the National Researc Council, the first volume of which appeared i 1926. In Chap. iii., Prof. Timerding gives critical account of the teaching of physics i elementary and in high schools. Although hi remarks have particular reference to German conditions, many interesting and generally applicabl aspects of the question are discussed. Teachin and research in the universities are also dealt wit and an account is given of the establishment an development of scientific societies and researc institutes, and of research publications.

The importance of experimental lecture demonstrations in university courses of physics has lon been recognised, and although the main lines experimentation are more or less fixed, eac department of physics has its own little specialitie University teachers are constantly on the look ou for new or modified experiments for lecture courses, and the editors of this 'handbook' have wisely included a section (Chap. iv.) on the technique of lectures, by Drs. Mecke and Lambertz, both of the University of Bonn. Many hundreds of representative lecture experiments on all branches of physics are described, numerous tables of data are given, and the text is copiously illustrated by excellent diagrams, many of which can be obtained from Dr. Mecke in the form of lantern slides. This collection of lecture experiments well repays careful study, and should prove invaluable to university lecturers in physics.

The volume under review is nicely printed on good paper, and is remarkably free from misprints. On p. 235, Fig. 21 has been erroneously inverted, and on p. 268 the melting point of mercury is given as 39° C.! R. W. L.

Primitive Ferns.

The Ferns (Filicales): Treated Comparatively with a View to their Natural Classification. By Prof. F. O. Bower. (Cambridge Botanical Handbooks.) Vol. 2: The Eusporangiatæ and other relatively Primitive Ferns. Pp. vi + 344 + 1 plate. (Cambridge: At the University Press, 1926.) 30*s*. net.

> "On a far-looking tower I stood to watch,
> And three tribes I beheld, of war-bands three."

THE prologue of this second volume on the ferns, opening as it does with this apt quotation from Way's translation of Euripides' "Suppliants," serves well to define the author's position in dealing with his theme. For having in his first volume built for himself a basis of morphological criteria, drawn from the entire range of fern life, he now proceeds to use it as a point of vantage from which to view the group as a whole. As the armies in the Greek play were seen to be formed in three distinct columns, each moving independently, so also the author sees three main phyla of ferns progressing from geological time in an evolutionary march, at first distinct and mainly divergent, but later converging in character in the more recent stages of phyletic advance. As in the battle graphically described in the play, the several columns finally merged in an inextricable mêlée, so in the later phases of fern evolution does the writer find the advanced members of his group, and his task of complete segregation of the several phyla of descent, according to their detailed features, grows in difficulty.

The broad basis of comparison which Prof. Bower has raised in his first volume, with the view of phyletic seriation of the ferns, is skilfully built on the values which he assigns to morphological features, each of which he has sought to weigh truly. The external morphology of the shoot, the internal constitution of the plant body as indicated by segmentation, the architecture and venation of the leaf, the vascular system, the dermal appendages, the position and structure of the sorus, the indusial protections, the characters of the sporangium and of the spores, the spore-output, the morphology of the prothallus, and the embryology of the sporophyte, have all fallen under his critical judgment during his lifelong and intensive study. Each he has examined critically in the ferns at large, and his views have not passed unchecked by the fossil records.

As the analysis has proceeded the conclusions have become more acceptable that the simple shoot, radial in construction, and commonly unbranched, is primitive, while the prone, dorsiventral, and unequally branched shoot is almost undoubtedly derivative. In relatively primitive ferns there are several initial cells in the apices of stem, leaf, root, and sporangium, while in later derivative types there is usually a single initial cell in the apices of these organs. The primitive forms of leaf are characterised by a dichotamised distal region, sometimes with basal stipular growths, and by leaf-segments which may be all separate, and each provided with a single vein. The primitive venation is open with free endings. In advanced ferns the leaf may be webbed, the venation reticulate, and the lower pinnæ arranged monopodially. The primitive axis is protostelic, the more advanced solenostelic, dictyostelic, polycyclic, or marked by further complications. Dermal appendages in the form of simple hairs constitute a primitive feature, while branched hairs, and in particular flattened scales, are held to be indicative of advance from simple hairs themselves. The marginal position of the sorus, more frequent in early than in late fern types, has passed in several distinct phyletic series into the superficial, as the area of the leaf-blade increased. The individuality of the sorus has also been lost in many sequences by fissions or by fusions, or the sori have been obliterated in time by spreading of the sporangia generally over the leaf-surface. The most important variations are, however, those of constitution of the sorus, three types of which have been distinguished, namely, the simple, gradate, and mixed. The first is characteristic of Palæozoic ferns, though it survives to the present day. The last is to-day prevalent but is absent in Palæozoic ferns. The gradate sorus is an intermediate type in many, but not all, phyletic lines.

There is no indusial protection in Palæozoic ferns, nor is such found in certain modern advanced types. But between such extremes protection by various means is provided notably by different types of indusium. The indusiate sorus is thus considered a later and derivative type, while on the other hand there is good evidence that the modern non-indusiate state has often resulted from the abortion of an indusium previously present. In the progression from Palæozoic to modern times the sporangium shows consistent reduction in size, with increasing specialisation of the mechanism of spore dispersal, while the sporangial form, length of stalk, and the position of the annulus and the stomium vary likewise in close relation to the constitution of the sorus. A gradual diminution of the spore-number accompanies the reduction and specialisation of the sporangium from geological time onwards. There is little to be gleaned for phyletic purposes from the vegetative features of the prothallus, though a surer basis for comparison seems to be provided by the sexual organs, and in particular by the antheridia, which are not only deeply sunk in the prothallus of the primitive ferns, but are also there massive, while in the more advanced types they project and are relatively delicate. As to the embryology of the ferns, it is held that the primitive embryo was probably a spindle-like structure with suspensor and shoot, while the root is an accessory organ of later development. The presence or absence of a suspensor is regarded from the phyletic viewpoint as the most important comparative feature relating to the fern embryo.

With the field of comparison thus widened the author proceeds to the detailed consideration of certain families which are held to be the most ancient among known ferns. These are the Cœnopteridaceæ and Osmundaceæ, which have had undoubted Palæozoic existence. With them are closely grouped for comparative reasons the Marattiaceæ and Ophioglossaceæ, as they also are Eusporangiate ferns.

The remainder of the ferns, though prefigured in some measure by fossils of the Palæozoic period, first began to assume their ordinary characters in the Mesozoic period or later. Their relationship is clearly with two relatively primitive families, namely, the Schiziaceæ and the Gleicheniaceæ, both of which became firmly established in early Jurassic times. The former bears its sori on the margins of the leaves, the latter produces them superficially. With their allies they constitute tw consistently defined series, the Marginales and th Superficiales, and are regarded as having no improbably originated from some common earlie source.

To the discussion of these fascinating an primitive families this beautiful book is mainl devoted. With consummate skill in presentation c fact and argument, and with a wealth of illustratio to illumine the written page, the author carries th reader through the intricacies of form and structur which the ferns display. It is only when th closing chapters are reached and the general revie of the primitive ferns as a whole has been read, tha a full appreciation is gained of the power of th argument which has guided the author throughou the arduous task of phyletic grouping. The consideration of the more advanced series of ferns i delayed to a later volume, but to all who read thi book must come a growing desire for the productio at an early date of the remainder of this fascinatin narrative of the march of evolution.

J. McL. T.

Our Bookshelf.

Measurements of the Cubical Contents of Fore Crops: being a Critical Investigation into th Methods of Measuring Sample Plots, wit special reference to the Liability to Error. B M. D. Chaturvedi. (Oxford Forestry Memoir No. 4.) Pp. xv + 142. (London: Oxford Un versity Press, 1926.) Paper, 10*s*. net; cloth 12*s*. 6*d*. net.

Sylvicultural research is becoming more and mor dependent on observations made in permanen sample plots. These plots are marked out in th forest, treated according to the desired exper mental methods, and the volume of timber standin in them is periodically measured. The value such observations is entirely dependent on th accuracy with which the volume of standing cro can be measured, and even small errors in th measurement of any plot may lead to very fals results. Thus if the volume of a plot increase in five years by 20 per cent., an error of +3 pe cent. in the first measurement and −3 per cen in the second may reduce the increment, a measured, to about 13 per cent. Fair accurac in measurement can be assured if a large numbe of sample trees can be felled for detailed scalin but the felling of numerous sample trees is generall sufficient to upset the sylvicultural experiment i hand.

In order to obviate these difficulties, nearly ever forest research station in Europe has designed i own method of measuring standing timber, and i is claimed that many of these methods give ver considerable accuracy. In the memoir und review, Mr. Chaturvedi has collected together a available records of these methods, and by personal visits to many of the continental research stations he has equipped himself with the latest relevant information. He has subjected the various methods to mathematical analysis, and has applied most of them to the measurement of certain plots in which all the trees were felled to allow of accurate volume determination, by which means he has obtained useful empirical evidence as to their relative reliability.

Mr. Chaturvedi also propounds a new method which aims at combining the good points of several other systems. This method avoids felling any excessive number of trees, and is well worth testing carefully in the field. W. E. H.

Tables of Physical and Chemical Constants; and some Mathematical Functions. By Dr. G. W. C. Kaye and Prof. T. H. Laby. Fifth edition. Pp. vii + 161. (London: Longmans, Green and Co., Ltd., 1926.) 14*s*. net.

SIX years have elapsed since the publication of the fourth edition of these invaluable tables, and it is significant of the change in scientific outlook that the first page of the book is now devoted to atomic numbers and the last to a new table of isotopes. In the list of elements in the order of atomic numbers, three numbers only, 61, 85, and 87, are still unrepresented; the first of these gaps will now be filled by the new element illinium, the isolation of which was reported in NATURE of June 5, 1926, p. 792. New matter has been added on the mechanical equivalent of heat, a subject which Prof. Laby has personally investigated, and the weighted mean of the determinations of Joule's equivalent made since 1880 is given as $4{\cdot}182 \times 10^7$ ergs per 20° calorie on the scale of the hydrogen thermometer.

The reviewer turned eagerly to the value assigned to Planck's constant, h, only to find that the authors have made no attempt to discriminate between the various experimental values quoted. Even the critical discussions by Ladenburg and by Birge are not referred to. The true value is probably very near to Planck's original estimate, $h = 6{\cdot}55 \times 10^{-27}$ erg sec. The same cautious attitude is adopted in the value quoted for the fundamental electron charge, which is given as $e = 4{\cdot}77 \times 10^{-10}$ e.s.u., with a reference to Millikan, July 1917. It may be suggested that in future editions more attention should be paid to spectroscopic constants—even Rydberg's constant does not appear to be mentioned—and other important constants associated with the quantum theory. Scientific workers owe a debt to the authors of this volume, which only those who have attempted to collect such numerical results can fully appreciate. H. S. A.

The Evolution and Development of the Quantum Theory. By N. M. Bligh. Pp. 112. (London: Edward Arnold and Co., 1926.) 9*s*. net.

PROF. MAX PLANCK, whose photograph adorns its frontispiece, contributes a short foreword to this little book. The author sets out with the praiseworthy object of producing a "concise handbook" for the "general scientific reader." In Part 1 he sketches the classical arguments leading to Wien's radiation law and the Raleigh-Jeans law, and describes how their disagreement with each other and with experiment led Planck to his formula and law. Part 2 is a description, which does not profess to be complete, of some applications of the theory; band spectra, for example, are barely mentioned in two sentences. Planck's second hypothesis and a somewhat irrelevant discussion of Nernst's heat theorem, however, fill a whole chapter. The chapters on the light quantum hypothesis, specific heats, and optical spectra, though of necessity brief, are good.

Unfortunately, the author is much at sea in radiation theory and statistical mechanics. Chap. i., his introduction to radiation theory, is so involved that it would be almost unintelligible to any one unfamiliar with the arguments used, and the proof of Wien's displacement law in Chap. ii. is still worse. In Chap. iii., on statistical mechanics, the preliminary explanation is worthless, while the proof of Maxwell's distribution law contains ". . ., let δn be the number of molecules having velocities whose x-components lie between u and $u + \delta u$"; and later, "$\Sigma \delta n = 0$," no distinction being made between that number and its variation. There is a considerable number of mis-statements, such as "A complexion is thus the number of ways in which a particular arrangement can be carried out," and "Now since the mass of the helium nucleus is slightly greater than that of the hydrogen nucleus," and misprints are frequent.

Animal Ecology. By Prof. A. S. Pearse. (McGraw-Hill Publications in the Zoological Sciences.) Pp. ix + 417. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1926.) 20*s*. net.

THE science of animal ecology is relatively new, but a considerable amount of attention has been directed to this aspect of zoology since the beginning of the century. In this development American biologists have played a leading part. We recall Shelford's valuable work on the animal communities in temperate America and Adam's useful guide to the study of ecology in this connexion, both of which gave a tremendous impetus to the study of animals in relation to their environment. Most of our knowledge of the subject is, however, contained in short scattered papers through a vast range of periodical literature or in more specialised works dealing with particular groups.

Some guide to this maze of literature was clearly needed, and Prof. Pearse has rendered conspicuous service in undertaking this task. His book seeks to indicate the scope of the subject and to outline its various sub-divisions. The treatment is of necessity brief, but with the aid of a comprehensive bibliography the reader is directed to fuller details regarding any particular aspect of the subject. The book should serve a useful purpose as a work of reference to university teachers and students in presenting to them a broad and orderly survey of a very large field.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

Atmospheric Circulation.

The omission of references seldom leads to intelligibility, and I fear I should have been unable to trace the review mentioned by Prof. W. H. Hobbs (Nature, Dec. 25, p. 915) had Mr. Bonacina not alluded to it in a letter to me. Prof. Hobbs asserts that my result (*Q.J.R. Met. Soc.*, 1926, 85-104) that the prevailing pressures around the poles should be low was explicitly stated by me to refer to an atmosphere circulating symmetrically over a uniform earth and unrestricted by friction. This is not the case. It is true that I worked out the solution of such a problem, but the result I obtained was that, with the highest temperatures over the equator, the pressure would increase all the way to the poles; this is diametrically opposite to Prof. Hobbs's attempted quotation. Prof. Hobbs omits to mention that I went on to examine which of the neglected factors was responsible for the chief difference between theory and observation; that I traced it to friction; and that my final inference of the existence of low pressures about the poles was the result of an argument depending essentially on friction. Incidentally, the despised frictionless theory, if adapted to cooled continents, would be in qualitative agreement with the facts as stated by Prof. Hobbs.

While this matter is under discussion reference must be made to a criticism by Mr. F. J. W. Whipple (*Q.J.R. Met. Soc.*, 1926, p. 333). I showed in my paper that if the prevailing circulation north of a given parallel of latitude is either easterly or westerly, it can be maintained against friction only by interchange of air with lower latitudes. Thinking that I had dynamical grounds for believing that this interchange would, in the conditions of the northern hemisphere, involve mainly south-west and north-east winds, I inferred that the polar circulations must be westerly. Mr. Whipple points out a weakness in the argument, and has led me to modify this conclusion. It seems clear that if there were no horizontal interchange of air, the effect of surface friction would be simply to make the air drift across the isobars until all differences of pressure at sea-level were annulled, and there would be no surface winds anywhere. Somehow this condition is forestalled by the development of irregular winds of cyclonic type, which maintain a continual interchange of air across the mean annual isobars, and the primary effect of such interchange, with an actual distribution of temperature, would probably be a transmission of angular momentum polewards, giving an equatorial belt of easterly winds with broad belts of westerly winds north and south of it. The winds at the southern boundary of the belt of prevailing westerlies in the northern hemisphere must be mainly north-east and south-west; but there seems to be no reason why they should persist all the way to the pole, and if the currents are deflected within this belt so as to become mainly north-west and south-east at its northern margin, they will be capable of maintaining an easterly circulation north of it.

Accordingly I see no great objection to anticyclonic circulations in Arctic and Antarctic regions. The main results that emerge from the discussion are that friction plays a dominating part in atmospheric circulation, and that cyclones are essential to the maintenance of any general circulation and are not disturbances superposed on it. Presumably the distribution of the belts of easterly and westerly winds would be affected by a change in the distribution of temperature in latitude.

Mr. Bonacina's quotation in his review (*Geog. Jour.*, Sept. 1926) expressed correctly the views I held at the time he wrote, but as a result of Mr. Whipple's note I have somewhat modified them in the sense indicated above. The question of the existence of glacial anticyclones strikes me as one to be settled by observation. I would only point out that the great majority of the observations quoted on the point are irrelevant. They refer to stations near the coast, where permanent outflowing antitriptic winds are to be expected whatever the winds in the interior of the continent may be. To infer an anticyclonic circulation over a glaciated continent on the basis of winds from the land at coastal stations is like finding out whether it is raining by turning the tap on. The observations in the interior of Greenland and Antarctica by Koch, de Quervain, and Scott, quoted by Prof. Hobbs in his book, are to the point, but none of the others are.

Harold Jeffreys.

The Significance of Phosphorus in Muscular Contraction.

An examination of the very extensive literature dealing with the function of phosphorus compounds in the chemical mechanism of muscular contraction reveals so many contradictory statements that it is evident that the technique in use must be subject to some serious fault. Since we have found what is probably the main cause of the discrepant results obtained in this field, it seems desirable to communicate our results without delay.

There appears to be in muscle tissue an organic phosphorus compound which, by reason of its great instability in acid solution, has been confused hitherto with inorganic phosphate, to which it gives rise in the course of the estimation of inorganic phosphates by the methods of Embden or of Briggs, or by any method involving the use of mineral acid. The confusion is increased by the fact that this substance, the organic phosphorus compound which we have designated 'phosphagen,' is intimately connected with the chemical mechanism of contraction; the estimation, therefore, of 'inorganic' phosphate by the above methods is hopelessly misleading, since by them one measures the sum total of two substances which vary independently in amount. It is possible, by avoiding the use of acid solutions, to estimate true inorganic phosphate, since 'phosphagen' appears to be stable in neutral or slightly alkaline solution. The following table, which concerns the gastrocnemius muscle of the frog, illustrates the changes in the amount of phosphate and 'phosphagen' in a muscle subjected to different treatments:

	Resting.	Rapidly Fatigued.	Heat Rigor.	Incubation in $NaHCO_3$.	
				Without NaF.	With NaF.
Inorganic phosphate . .	20	50	90	110	20
'Phosphagen'	65	25	0	0	0
Sum total .	85	75	90	110	20

The figures are given as milligrams of phosphorus per 100 gm. of muscle, and are representative of a number of experiments. The third row of figures corresponds to the 'inorganic' phosphate as estimated by the ordinary methods.

These facts suffice to explain many of the anomalies to be found in the literature. We will deal here with only one of these. Embden and his co-workers have noted a disappearance of inorganic phosphate in a suspension of minced muscle in sodium fluoride solution. They have attributed this to a synthetic action of the fluoride ion. Comparing the first and last columns in the above table there is an apparent synthesis of 65 mgm. of 'inorganic' phosphate into something not estimated by the Embden technique. The real state of affairs, however, seems to be that the true inorganic phosphate is not affected at all. Either the fluoride ion catalyses the conversion of 'phosphagen' into some acid-stable compound, or else it poisons a catalyst which normally causes its transformation into inorganic phosphate. Rapidly induced fatigue produces a similar but smaller effect.

One further point of interest worthy of note here is that while unstriated muscle contains about the same amount of genuine inorganic phosphate as does striated (skeletal) muscle, it appears to contain no 'phosphagen.' The heart muscle of the frog also gives about 20 mgm. of inorganic phosphorus per 100 gm. of muscle, together with a slight but definite amount of 'phosphagen.' One is tempted to correlate the 'phosphagen' content of a muscle in its resting condition with its ability to respond to sudden demands for violent activity.

Whilst we have at present no definite knowledge of the nature of this substance, it seems quite possible that it may be the unstable ('active') hexose monophosphate, the existence of which was inferred by Meyerhof in interpreting the phenomena of glycolysis in cell-free muscle extracts, and the fermentation of sugar by yeast.

P. Eggleton.
M. G. Eggleton.

Dept. of Physiology and Biochemistry,
University College, London,
Jan. 5.

Effect of a Large Number of Receiving Aerials on the Propagation of Wireless Waves.

In connexion with some experiments, I was led recently to estimate the extent to which a large number of receiving aerials would contribute to the absorbing effect of the earth's surface on wireless waves in resonance with them. A short calculation showed that, with a density of aerial distribution such as now exists in an urban district surrounding a local broadcasting station, the energy absorbed by the aerials should be the decisive factor in determining the surface attenuation. Since the aerials would naturally only effect those waves which were very close to wave-lengths to which they were tuned, it was not difficult to test this conclusion. A number of experiments have been made on the general principle of measuring the intensity of waves which have travelled across a considerable area containing large numbers of broadcasting aerials, the wave-length being gradually varied from just below to just above the normal wave-length of the local broadcasting station (2 LO) to which the majority of the aerials may be assumed to be tuned (that is, a wave-length of 364 metres).

These experiments, which were carried out with the assistance of Dr. Smith-Rose and Mr. Munro, with the kind co-operation of the B.B.C., have yielded results that constitute very definite evidence of a critical effect of large magnitude occurring at or near the resonant wave-length, and the phenomenon appears only ascribable to the selective action of the multiplicity of tuned aerials in the path of the waves. Thus, at Slough (see Fig. 1), when receiving from the 2 LO transmitter at Marconi House, an increase in intensity of the order of 90 per cent. was observed for a variation in wave-length of only 5 per cent.; while it will be seen that for a wave-length change of 120 metres a total increase of field strength of nearly five to one was obtained; that is, for a given power transmitted, the received power increased more than twenty-fold.

Now the hypothesis that this effect is mainly due to the transmitted waves passing in and out of resonance with the aerials in their path is confirmed by the fact that the effect was found to increase in proportion to the distance which the waves travelled over crowded residential districts, and was negligible when the wave path lay almost entirely over open country with only a small residential area round the transmitter. The hypothesis was further confirmed by the fact that the effect was shown not to be peculiar to a given transmitter or receiving site. On the other hand, it seems at first to be contradicted by the fact that the minimum intensity, and therefore apparently the maximum absorption, does not occur at the resonant wave-length but at a wave-length considerably below. In some cases the minimum had not been reached at 300 metres, below which wave-length experiments have not yet been carried. A brief study of the theoretical side of the problem, however, shows that this is not necessarily the case. If an electromagnetic wave is propagated in a medium containing resonators of all one periodicity, it is well known that, on varying the wave-length of the waves in the neighbourhood of the resonant value, there is a critical change in the medium, not only of its absorption factor but also of its refractive index, the latter being responsible for the optical phenomenon of anomalous or selective dispersion.

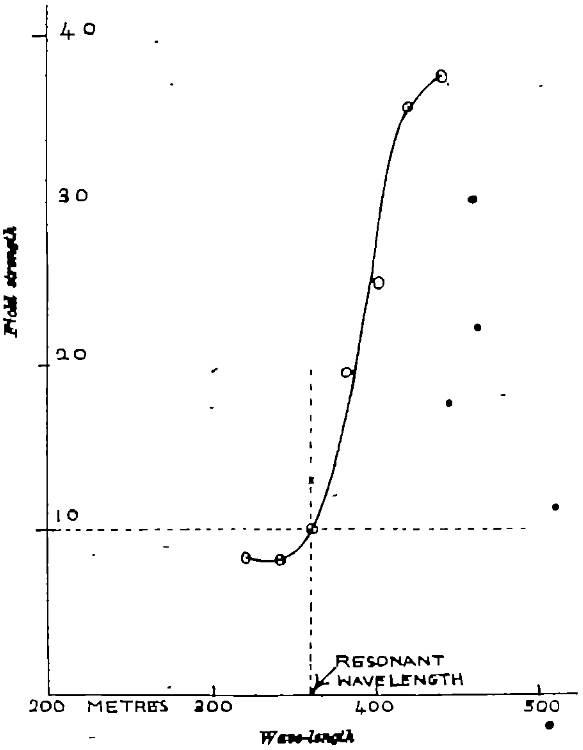

Fig. 1.—Effect of wave-length change on received field strength. Transmitter—2 LO. Receiver—Slough.

Now there is an undoubted analogy between this and the experiments under discussion. The medium containing resonators is in this case the layer immediately above the earth's surface containing the tuned aerials. We must, therefore, take into account the possible effect of a change in the refractive index of this medium as well as in its absorption factor. But the theory of wireless wave propagation as developed by Sommerfeld and others shows that the former factor may be as important as the latter in determining the attenuation which the waves will experience in passing over the earth's surface. Finally, the theory also shows that a variation of the refractive index with the wave-length in the manner demonstrated in theoretical and experimental optics in such circumstances (anomalous dispersion) would have a tendency to cause the point of maximum attenuation (and therefore minimum received intensity) to be shifted to the left of the critical wave-length line, as it was found to be from observation. This is manifestly only a tentative explanation, but it is enough to show that this unexpected feature in the experimental results does not invalidate the general conclusion that the large number of receiving aerials in the London area have a very marked absorbing effect on the waves passing over them.

The observations on which the above note is based were carried out as part of an investigation for the Radio Research Board of the Department of Scientific and Industrial Research.

R. H. Barfield.

Radio Research Station,
Ditton Park, Slough, Bucks, Dec. 6.

Relation between the Reciprocal Impenetrability of Matter and Pauli's Exclusion Principle.

When the collisions between the molecules of an ideal gas are taken into consideration, then the motion of the gas does not appear to be multiply periodic. It is therefore impossible to quantise this motion by means of the 'classical' quantum theory. Moreover, in the treatment of the ideal gas by means of the new 'undulatory mechanics,' hitherto only the impenetrability of the walls of the vessel has been taken into account, and not the reciprocal impenetrability of the molecules (E. Schrödinger, *Phys. Zs.*, 27, 95, 1926). I propose to show here that, in the case of impenetrable moving *mass-points*, wave-mechanics gives an exact and very elementary solution. Simultaneously we arrive at the relation mentioned in the title.

For purposes of brevity we will limit ourselves to a 'one-dimensional' gas: N monatomic mass-points of equal mass M are enclosed in a tube, which extends from $x = -\frac{\pi}{2}$ to $x = +\frac{\pi}{2}$. If we first take into account only the impenetrability of the ends of the tube, then we have to look for all the solutions of the N-dimensional Schrodinger-equation:

$$\left[\frac{\partial^2}{\partial x_1^2} + \frac{\partial^2}{\partial x_2^2} + \ldots + \frac{\partial^2}{\partial x_N^2} + \frac{8\pi^2 M}{h^2}E\right]\psi = 0, \qquad (1)$$

which are equal to zero at the faces of the N-dimensional $\pm\frac{\pi}{2}$-cube. These solutions are:

$$\psi = \cos a_1x_1 \cos a_2x_2 \ldots \cos a_Nx_N, \qquad (2)$$

where $a_1 \ldots a_N$ are arbitrary positive integers and where $E = \frac{h^2}{8\pi^2 M}(a_1^2 + \ldots a^2_N)$. To the same E, and with the same numbers $a_1 \ldots a_N$, there belong also all the solutions obtained from solution (2) by exchanging all the co-ordinates $x_1 \ldots x_N$ with each other, at the same time keeping the numbers $a_1 \ldots a_N$ fixed. By multiplication of all these solutions by arbitrary constants and addition, we obtain the most general solution of this kind:

$$\Psi = \Sigma C(p_1 \ldots p_N) \cos a_1x_{p_1} \cos a_2x_{p_2} \ldots \cos a_Nx_{p_N}, \qquad (3)$$

where $p_1 \ldots p_N$ signifies *one* permutation of the numbers $1 \ldots N$, and the summation must be taken over *all* the permutations.

Now let us also consider the reciprocal impenetrability of the molecules. That can be done by means of the additional 'diagonal-restriction'; which in wave-mechanics corresponds to the impossibility of two molecules occupying the same point in space at the same time. Of all the solutions of the form (3), only those are allowed which are *also* equal to zero at all points of the $\frac{N(N-1)}{2}$ flat 'diagonal-spaces' of $N-1$ dimensions which are represented by the equations $x_h = x_k (h, k = 1, \ldots N)$. It can be shown now best by considering first the cases $N=2$ and $N=3$ that all the constants $C(p_1 \ldots p_N)$ must have values equal to each other or opposite in sign, according as the arguments $p_1 \ldots p_N$ are derived from the numbers $1 \ldots N$ by an even or an odd number of simple permutations. Or, in other words, ***because of the reciprocal impenetrability of the molecules*** only the ***antisymmetric*** solutions are allowed:

$$\Psi^{\text{antisym}}(x_1 \ldots x_N) = C \cdot \begin{vmatrix} \cos a_1x_1 & \ldots & \cos a_1x_N \\ \vdots & & \vdots \\ \cos a_Nx_1 & \ldots & \cos a_Nx_N \end{vmatrix}. \qquad (4)$$

Thus, just those solutions which, according to the researches of Heisenberg and Dirac, are connected with Pauli's exclusion principle (the exclusion of equal quantum numbers for two electrons in the same atom—in our case for two gas molecules in the same vessel), the determinant becomes identically equal to zero when two of the numbers a_s are equal to each other.

Finally, we may remark as follows:

I. For a three-dimensional gas contained in a vessel of *general* form, naturally $\psi_{\alpha\beta\gamma}(xyz)$ must be substituted for $\sin ax$; further, in the 'diagonal-restriction' the equations $(x_h - x_k)^2 + (y_h - y_k)^2 + (z_h - z_k)^2 = 0$ for $x_h = x_k$, and we have always to exchange a triplet $x_hy_hz_h$ with a triplet $x_ky_kz_k$.

II. In order to show that the impenetrability of the walls and for the molecules must really be expressed by the corresponding zero-conditions of the solutions of the Schrödinger equation, we approximate first this impenetrability by continuously varying forces of repulsion and then we go in the resulting solutions to the limit.

III. At the same time we get very simple models for the treatment of the question of how far the Pauli's exclusion principle holds for two electrons if they are in the same atom but not if they belong to distinctly separated atoms.

IV. The non-validity of Pauli's principle for 'light-corpuscles' should now perhaps be connected with their reciprocal *penetrability*, though the very provisional and symbolical character on one hand of the light corpuscles, and on the other of the multi-dimensional wave-equation (1), should specially be remembered here. These remarks and some connected statistical questions will be dealt with elsewhere.

Paul Ehrenfest.

Instit. v. theor. Natuurkunde,
Leiden, Holland.

The Imperial Forestry Institute.

SOME comment is called for on the note on the Imperial Forestry Institute which appeared in NATURE of Jan. 15, p. 96, and which is likely to produce a wrong impression in the minds of those unacquainted with the facts. With reference to a proposal to spend a sum of £75,000 on the erection of new buildings to accommodate the Imperial Forestry Institute at Oxford, the following observation is made: "On the face of it the scheme appears to be a laudable one. Nevertheless, it would seem to demand further careful consideration if this money or the bulk of it is to be provided from the Treasury." As there has been no suggestion that the Treasury should make any contribution towards the scheme, the fears expressed in regard to national expenditure may in this instance be set at rest.

The note concludes with the following passage: "Two points appear to demand a public and unbiassed inquiry before the Government is committed to the scheme; they are: (1) Are not the existing schools of forestry capable of giving all the education required, both up to the degree and post-graduate, and to undertake research? (2) Is it advisable to shut up forestry education in a water-tight compartment?" The writer is apparently not aware that such an inquiry was carried out a few years ago by an Interdepartmental Committee on Imperial Forestry Education, which issued in 1921 a report published as Command Paper 1166. In this report both the above questions are definitely answered in the negative. In proposing the establishment of a central institution for higher training and research in forestry, the Committee made it clear that there was no intention of interfering with the work done by university schools of forestry, and provided the training of these was maintained at a required standard, it recommended that selected students from these schools should be eligible for admission to the central institution. The Committee may be presumed to have conducted its inquiries in an impartial manner; it visited the universities of Oxford, Cambridge, Bangor, and Edinburgh, and also took evidence from other universities, as well as from institutions and societies interested in forestry, and in selecting Oxford as the site of the future forestry institute we may assume that it selected that place which it considered most suitable for the end in view.

Apart from the Interdepartmental Committee, the question was carefully considered by two separate Empire Forestry Conferences, one held in London in 1920 and the other in Canada in 1923. At both conferences the inadequacy of the existing arrangements for higher training and research in forestry was commented on, and the necessity for establishing a central institution for the needs of forestry in the British Empire was urged. The Interdepartmental Committee's recommendations were endorsed by the second Empire Forestry Conference and also by the Imperial Economic Conference held in London in 1923. The Imperial Forestry Institute was accordingly established at Oxford and started work in October 1924. Should any readers of NATURE be interested in the progress actually made so far, I shall be pleased to send them a copy of the second annual report.

R. S. TROUP.

Imperial Forestry Institute,
Oxford, Jan. 19.

IF under "Treasury" Prof. Troup includes the Colonial Office and Forestry Commission (the latter two offices defraying the bulk of the expenses of the Institute at present), the tax-payer, whether in Britain or overseas, will be relieved to have the assurance.

Prof. Troup's somewhat *ex parte* account of the proceedings leading up to the inauguration of the Institute in 1924 has in one form or another appeared on several occasions in the Press. He does not, however, appear to realise that a growing body of scientific opinion is at the back of the representations which the authorities of the Universities of Cambridge and Edinburgh placed before the Secretary of State for the Colonies and members of the Forestry Commission on the subject of the concentration of (State-subsidised) post-graduate forestry work of all kinds at one university. The authorities of the two universities stated quite definitely that they had no intention of giving up the post-graduate courses they had already inaugurated, and all they asked for was an 'open door.' It is understood that the Secretary of State accorded a sympathetic hearing, and intimated that whilst nothing could be done at the moment, the experiment was only made for a five-year period and would be open to a reconsideration at the end of the period.

THE WRITER OF THE NOTE.

Ionisation in Hydrogen Chloride Vapour.

BEFORE a meeting of the American Physical Society in April 1925, I reported some preliminary results of an investigation of ionisation by electron impact in hydrogen chloride vapour at low pressures, using the familiar method of mass spectrum analysis to identify the ions produced. I had observed in large numbers both positive and negative ions of which the ratio of mass to charge was about 36 times that of the hydrogen nucleus. At relatively high pressures I had also detected positive ions of *m/e* about 72 times the same unit. At all pressures the ions H^+, H_2^+, and $(H_2O)^+$ had been present, although in general there were fewer of these than of the other types.

Since then the study has been extended, using a new apparatus of higher resolving power. The ions at '36' were resolved into four separate types of positive ion, namely: $(Cl^{35})^+$, $(HCl^{35})^+$, $(Cl^{37})^+$, and $(HCl^{37})^+$; and only two types of negative ion, presumably $(Cl^{35})^-$ and $(Cl^{37})^-$. The ratios $(Cl^{35})^+/(Cl^{37})^+$, $(HCl^{35})^+/(HCl^{37})^+$, and $(Cl^{35})^-/(Cl^{37})^-$ were equal, within the limits of error, to the computed abundancy ratio of the isotopes based on the atomic weight of chlorine. The heavier ions previously mentioned were not observed at the lower pressures necessarily used in the new apparatus, and therefore could not be precisely identified.

Comparisons of the relative numbers of the different ions under many different conditions of pressure, energy of striking electrons, etc., have led to the conclusion that the only type of ion produced by an impact of an electron of between 4 and 75 volts energy on a hydrogen chloride molecule is $(HCl)^+$. This is the type of ion to which corresponds the ionisation potential of about 13·8 volts observed by others.

A widely held conception of ionisation by impact in hydrogen chloride assumes that the primary process consists of the formation of H^+ and Cl^- ions. The conclusion reached in these experiments is contrary to this assumption, though it was difficult to disprove the possibility, since both H^+ and Cl^- ions were produced. However, (1) it was observed that at low pressures there were always more H_2^+ ions than H^+; (2) neither of these showed any reproducible quantitative relationship to the $(HCl)^+$ ions; (3) their number was always small compared with the latter, except when the apparatus had been evacuated only recently; and (4) they diminished and *finally disappeared* with time, as the apparatus stood for days continuously evacuated.

These results and others led to the conclusion that the hydrogen ions came not from HCl molecules but from H_2 molecules formed probably by some process requiring the presence of the hot filament and of water vapour given off by the walls of the tube. Furthermore, the arrangement of the electrodes and fields in the tube permitted the discovery that the Cl^- ions observed came from close to the filament and that none came from any region in which electrons of more than three or four volts energy were available for impact. It thus seems possible not only to account for the existence of the H^+ and Cl^- ions but also to eliminate them definitely as the products of inelastic electron impacts of 13·8 or more volts with HCl molecules.

A detailed report of the experiments is being prepared for publication.

HENRY A. BARTON
(National Research Fellow).

Jefferson Physical Laboratory,
Harvard University,
Cambridge, Mass., U.S.A.,
Dec. 16.

A New Pressure-Temperature Formula for Vapours.

ABOUT forty formulæ have been proposed to represent the relation between the pressure p and temperature t of saturated vapours. The suggested formulæ reproduce the experimental results only on a limited part of the vapour-pressure curve, and not on the whole of it. Many of them give inexact results at very low temperatures or in the proximity of the critical point. Finally, none of them reproduces the critical point as the singular point (end-point, *le point d'arrêt*) of the pressure-temperature curve.

I have succeeded in finding a formula which satisfies all the claims both in respect to precision and in respect to correct reproduction of the conditions on the limits.

The formula may be written as follows:

$$t+c=k\left(\sqrt[4]{p}-10^{\alpha-\frac{\beta}{\log p_k-\log p}}\right), \quad . \quad . \quad (1)$$

where p_k is the critical pressure, and c, k, α, β are constants, different for different substances.

At pressures p sufficiently high (for ordinary liquids, throughout the range from 1 - 3 atmospheres up to the critical pressure), the difference $\log p_k - \log p$ is small. The exponent $\alpha-\frac{\beta}{\log p_k-\log p}$ is therefore a negative number with a large absolute value, so that the exponential term practically does not differ from zero. The formula thus becomes simply

$$t+c=k\sqrt[4]{p}. \quad . \quad . \quad . \quad . \quad (2)$$

Such a linear relation between t and $\sqrt[4]{p}$ was found in 1883 by Jarolimek.

At $p=p_k$, t, as given by the formula (1), changes discontinuously; thus the formula reproduces the critical point. When p is extremely small (therefore at very low temperatures) the term $\sqrt[4]{p}$ disappears in comparison with the exponential term, and the formula becomes

$$\log p=\log p_k-\frac{\beta}{\alpha-\log\left(-\frac{t+c}{k}\right)}. \quad . \quad (3)$$

Formula (1) represents with sufficient accuracy the experimental data for the most varied substances; for example, for liquid metals (also for mercury in the whole explored interval from 0° to 880°), for organic liquids studied by S. Young, and for permanent gases.

The constant c has usually the values lying between 0 and 273. Helium shows a remarkable peculiarity: it has $c=273$; thus, for helium the fourth root of the vapour pressure, in virtue of formula (2), appears to be approximately proportional to the absolute temperature.

Water, as usual, shows an anomaly: the index of the root is here 13/3 instead of 4.

A detailed account will be published in one of the physical journals.

A. BATSCHINSKI.

Thermotechnical Institute,
Moscow, Dec. 18.

'Hard Seeds' in Leguminosæ.

IT may be of interest to Mr. Alexander Nelson and to other readers of NATURE (Dec. 4, 1926, p. 804) to know that sulphuric acid has been used industrially for the promotion of germination in hard leguminous seeds for some years. The substitution on an extensive scale of *Indigofera arrecta* for the previously cultivated *Indigofera sumatrana* by the indigo planters of Bihar during the early years of the century was, in fact, made possible largely by the introduction of the sulphuric acid method of seed treatment into their agricultural practice. The seed of *Indigofera arrecta* grown in Bihar was found to possess a very hard coat and to fail to germinate almost entirely under the conditions of soil moisture prevailing in northern India. Treatment with sulphuric acid led to perfect germination in a well-ripened sample of seed, and the method was used for many years and is, I believe, still used by the Bihar planters. The procedure differs slightly, however, from that indicated by Mr. Nelson in that concentrated, instead of dilute, acid is employed. A full description of the method as used in Bihar may be found in my report to the Bihar Indigo Planters' Association for the year 1906–7.

I reported the successful application of the procedure to other hard seeds, those of a series of fibre-yielding jungle plants not exclusively Leguminosæ, in collaboration with R. S. Finlow in the *Proceedings of the Asiatic Society of Bengal* (New Series, vol. 3, No. 10) in 1907. Some of these seeds withstood the action of the concentrated acid for surprisingly long periods and germinated satisfactorily after it.

In the same year a paper in which an attempt was made to explain the cause of hardness in the seeds of *Indigofera arrecta* was published by D. L. Day and myself (*Annals of Botany*, vol. 21, No. 81). Our findings, as regards hardness being due to a surface deposition on the seed-coat, were in accordance with those of Mr. Nelson; we were, however, unable to determine the precise nature of the coating. Information on this point will be most interesting.

C. J. BERGTHEIL.

The Biological Station,
Nanaimo, B.C., Dec. 27.

Television.

As Mr. J. L. Baird, in NATURE of Jan. 29, mentions my name in connexion with 'television,' it may be of interest if I give a brief résumé of the demonstrations Mr. Baird has given to me at Motograph House. Last June he gave a demonstration of the transmission of the images of living people, showing gradations of light, shade, and detail. An account of this demonstration was published in NATURE of July 3.

The images, naturally, were not comparable with those shown on a modern cinema screen, but the likenesses were unmistakable. The person whose image was transmitted sat in a flood of brilliant light. Mr. Baird has now developed a method by which the image of the person is transmitted although he is in complete darkness. This result is obtained by flooding the 'sending' room by infra-red rays. On Nov. 23 last, Mr. Baird gave a demonstration to Mr. W. R. Crookes and me. One of us stayed in the sending-room with a laboratory assistant in apparently complete darkness. In the receiving-room, on another floor, the image of the assistant's head was shown brilliantly illuminated on a screen, and all the motions he made could be readily followed.

These images were not outlines or shadowgraphs, but real images by diffusely reflected rays. The application of these rays to television enables us to see what is going on in a room which is apparently in complete darkness. So far as I know, this achievement has never been done before.

We had the impression that the image on the screen was not quite so clearly defined as when visible rays were used, but we easily recognised the figures we saw, and made out their actions. The direct application of Mr. Baird's invention in warfare to locating objects apparently in the dark seems highly probable, but I hope that useful peace applications will soon be found for it.

Alexander Russell.

Faraday House,
Southampton Row, W.C.1,
Jan. 28.

Relativity and the Observer.

In Mr. Bertrand Russell's article in the new volumes of the "Encyclopædia Britannica" entitled "Relativity: Philosophical Consequences," there occurs the following sentence: "The 'observer' who is often mentioned in expositions of relativity need not be a mind, but may be a photographic plate or any kind of recording instrument." I should like to know how far Mr. Russell can claim to be in agreement with physicists on this point. For my own part it would seem to make complete nonsense of the theory. As I understand the principle of relativity, every object which can be observed, including the measuring rods and clocks which are used to observe, not excepting the retina of the observer's eye, undergoes transformation when the observer passes from one system of reference to another. If it is not so, if there be one piece of matter which can claim to be privileged, be it only a single electron, what, I ask, is the use or meaning of the principle ?

However, I propose a simple test. Will Mr. Russell —and any one who thinks he is right—read the article by Mr. J. H. Jeans on "Relativity" which immediately precedes his own article, and wherever he finds the word observer, make the substitution "photographic plate or any kind of recording instrument," and see if he can make sense of the principle.

I agree that the observer need not be a mind if by mind is meant anything over and above the simple spiritual or ideal act of observing, but the observer most certainly cannot be the observer's body or a part of his body or the instrument he uses, for no particle of such material structure possesses any privilege in the physical world. Surely if it did the principle of relativity would be superfluous, for the privileged object would itself provide an absolute system of reference.

H. Wildon Carr.

405 West Adams Street,
Los Angeles, California, Dec. 22.

The Continuity of Existence.

Recently, in an address to the British Academy, Prof. T. Percy Nunn propounded the idea that the existence of an electron is not necessarily continuous, and that when an electron revolving in an orbit about a nucleus changes to another orbit, it is possible that the electron goes out of existence in the first orbit and comes again into existence in the second orbit. It is of interest that Planck's theory that action is not a continuous entity but consists of discrete quanta leads to a similar conclusion.

A point of our ordinary space has in Einstein's fourfold world a record that is called its world line. As a bundle of energy such as an atom or electron or nucleus has extension, it is appropriate to call its record in the fourfold its world-filament. Since energy integrated through an interval of time is action, this filament of the atom is action; and the atom or energy is the section in which our space cuts the filament.

In this picture action is represented as a continuous filament. This representation contradicts Planck's theory, and the picture must be amended in order to conform. The filament must be replaced by a series of quanta dotted along a line.

Consider now what happens as our space travels through the fourfold world. In some positions it will intersect a quantum of the series dotted along the line; in other positions it will miss. The atom or bundle of energy, being the intersection of the action by our space, will exist when our space intersects a quantum, and will not exist when there is no intersection with a quantum. In other words, as our space travels through the fourfold (that is to say, as time passes) the atom or bundle of energy keeps flashing into existence and out again.

D. B. Mair.

Double-Image Effect in Transparent Microscopic Spheres.

In a paper published by us in the current number of the *Proc. Roy. Soc.* on the "Scattering of Light by Individual Particles in Smoke," we have directed attention to a double image effect exhibited by transparent microscopic spheres. As a result of further experiments we have found that the explanation of the effect given requires some modification. One of the images is due to reflection from the surface of the sphere instead of to internal reflection. As was suggested to us by Prof. Tyndall, this can be seen by placing a small bulb containing a gold sol in the beam of light from an arc, when one image is coloured red and may be seen to be due to refraction through the sol, whilst the other is white and is produced by reflection from the surface of the sphere.

H. S. Patterson.
R. Whytlaw-Gray.

Helium or Helion ?

May I invite the opinion of readers of Nature as to the desirability of changing the name of element No. 2 from helium to helion ? This element was christened at a time (1868) when its existence was recognised on the strength of the D_3 line in the chromosphere, and when, in view of the proximity of this line to the D lines of sodium, it appeared not improbable that it was a metal. Now that helium has been isolated, liquefied, and even solidified, we know that it is typically non-metallic, exactly like argon and the other inert gases discovered in later years, and now placed in group 0 of the Periodic System. Its present name, therefore, is anomalous.

J. Newton Friend.

Municipal Technical School,
Birmingham, Dec. 9.

Changes in the Length of the Day.

By Prof. Ernest W. Brown, F.R.S.

At the present moment the answer to the question as to whether the rate of rotation of the earth is fluctuating, depends almost wholly on the interpretation which shall be given to certain differences between the observed positions of two or three bodies in the solar system and their positions as calculated from the laws of motion and gravitation. Owing to the unavoidable errors of observation, usually greater in the past than now, a detailed discussion of the astronomical data is necessary in order to discover, if possible, the extent to which the astronomical evidence is reliable. To me it has appeared to be sufficiently good to warrant full consideration of its consequences and to suggest further search for confirmation of the results.

Although these fluctuations appear to be physically independent of the well-known progressive change due to tidal friction, the latter is included with the former in the astronomical observations, and this fact requires a knowledge of the amount of the progressive change in order to isolate the fluctuations.

The progressive change is mainly determined from a comparison of material deduced from ancient eclipses with modern observations. Dr. J. K. Fotheringham's latest determination of the frictional portion gives an amount the cumulative effect of which at the end of a century is to change the apparent longitude of the moon by 4″·5; since it varies as the square of the time, the accumulation in a decade is less than a twentieth of a second of arc. An apparent displacement of the sun of the same character had been deduced earlier by Dr. P. H. Cowell; for this Dr. Fotheringham gets a century accumulation of 1″·5, but states that any values between 1″·1 and 1″·7 will satisfy the observational material.

The hypothesis that these amounts were due to tidal friction was first placed on a numerical basis by Prof. G. I. Taylor, who showed that shallow seas must be mainly responsible, and that, in particular, the Irish Sea produced about one-fiftieth of the observed amount. Shortly after, Dr. H. Jeffreys, from such data on tides, currents, and ocean depths as were available, deduced in the same manner from all the shallow seas of the globe an amount not very far from that obtained by astronomical observation; in fact, the two values agreed well within the errors due to the uncertainty of the data.

The apparent solar effect bears, however, a relation to the apparent lunar effect, which depends mainly on the amounts of the friction which are to be attributed to the solar and lunar tides respectively. Jeffreys showed that if we accept Fotheringham's figure for the apparent lunar effect, the maximum apparent solar effect in a century, namely, 0″·9, is obtained when we attribute all the friction to the lunar tides. This is somewhat less than the least figure, 1″·1, admitted by Fotheringham.

While the discrepancy exists and is in need of explanation, too much stress should not be placed upon it in view of the uncertainty of much of the material used to deduce the results. The hypothesis of continental drift has some bearing on the question. Practically the whole of the ancient astronomical observations were made in a restricted area on the earth's surface. If this region had drifted relatively to the rest of the earth in the direction opposite to the tidal drift, that is, east, by a sensible fraction of the total tidal retardation, the discrepancy would disappear. In this sense the drift could scarcely be tidal; if its existence be postulated, an internal source seems to be necessary.

In extrapolating these results into the past or future, it is to be remembered that the astronomical observations cover less than 4000 years, while the frictional calculations depend only on modern data. The discussion of the latter by Jeffreys showed that two-thirds of the whole amount was due to the Bering Sea alone. This sea is bordered on the south by the Aleutian Islands, which now constitute a region of considerable seismic and volcanic activity. From what we know of changes of ocean depth in such regions, there is no security that changes in the depth of this sea may not have taken place, even within historic times, sufficient to modify sensibly the total amount of tidal friction. While a retardation of the rate of rotation by tidal friction has certainly existed throughout the geologic history of the earth, its amount has probably been subject to considerable variations, and the same may be said of the future.

The results contribute nothing to a hypothesis which demands a sliding of the crust as a whole over the nucleus if the assumed angular velocity of relative shift be constant. While a retarded or accelerated effect is not excluded, the substantial agreement of the observed and computed friction indicates that it is probably, if existent, quite small. The same reasoning can be applied to other frictional effects; for example, that of an assumed general average circulation of the atmosphere relative to the earth's surface.

We now come to the fluctuations in the earth's rate of rotation which are indicated by the astronomical evidence. There are accelerations and retardations of an order of magnitude quite different from that of the frictional effect. There have been decades in which the accumulated apparent change from uniform motion has been several seconds of arc, while that due to friction in similar periods is less than one-twentieth of a second, as pointed out above. Since the frictional effect has always the same sign, while these fluctuations have both signs, they cannot be due to variations in the amount of friction, or indeed to any frictional effect caused by attractions of bodies outside the earth. Before discussing their origin further, however, I shall give some indication of the evidence on which their existence is postulated.

Briefly stated, the astronomical evidence comes mainly from a comparison of the deviations of the moon and sun from their gravitational orbits, with confirmatory evidence from the transits of Mercury. The earth is the clock by means of which the rates of motion of these bodies are measured. If the rate of the clock varies, the apparent changes in the rates of motion of other bodies will be substantially proportional to the rates themselves. The best test of the clock is the fastest moving body which has been sufficiently observed, namely, the moon. The latter exhibits apparent variations which are much too large to be attributed to defects either in the observations or in the gravitational theory. When we examine the observations of the sun, after applying all known corrections, including the secular acceleration, we find a similar set of variations of the right order of magnitude. But as the angular motion of the sun is less than 1/13 that of the moon, the variations are less in this proportion, and consequently are observable with a corresponding degree of uncertainty. In fact, it is only by combining all the existing material that we can feel any degree of confidence in their existence.

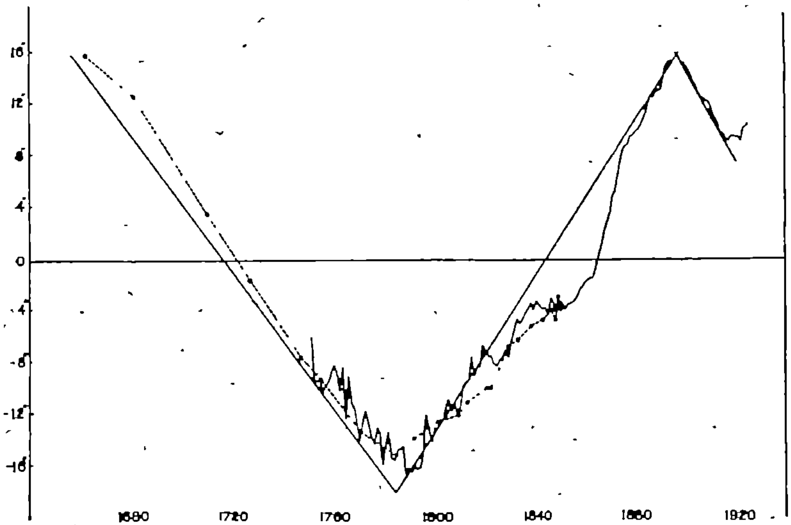

FIG. 1.—Fluctuations of the moon's mean longitude from Greenwich meridian observations (full line), and from occultations (broken line). The inclined straight lines are guides for the eye.

While the motion of Mercury round the sun is four times as fast as that of the earth, the relative lack of observational material more than offsets the advantage gained by the speed of motion. Nevertheless, the valuable work done by Mr. R. T. A. Innes in discussing these observations, the results of which led him to revive Newcomb's original hypothesis, constitutes an important addition to the evidence furnished by the moon and sun.

Fig. 1 exhibits the deviations of the moon in longitude from its gravitational orbit (which latter includes the frictional effect) as judged by the Greenwich meridian observations (full line) and the occultations (broken line); the inclined straight lines are merely guides for the eye. After 1850, the two sets and other observations so nearly agree on the scale of this figure that the Greenwich material is alone shown. The main outlines of the fluctuations with a minimum near 1790, a maximum close to 1898, and a marked change near 1917, are evident. Details before 1850, and in particular between 1810 and 1850, are doubtful; it seems that one set was subject to systematic errors which lasted for many years.

Fig. 2 shows (full line) the corresponding deviations of the sun as obtained from Greenwich, on a much smaller scale; the broken line is the full line curve of Fig. 1 with each ordinate divided by 13·3—the ratio to be used for the hypothesis of a change in the earth's rate of rotation. The coincident changes about 1898, 1917, are well marked; that at 1790 is doubtful, on account of the large deviations which follow this date. Comparison with observations from other places appears to indicate defects in the Greenwich material for the sun in this period, and, judging by the occultations, for the moon also. The same comparison indicates systematic errors of observation throughout the whole range which, while not large enough to change the principal correlations, are large enough to account for the differences between the second halves of the curve in Fig. 2.

The evidence thus favours the hypothesis of changes in the earth's rate of rotation rather than that of unknown forces affecting the motions of the bodies in this particular manner. If it be adopted, it is easy to prove that, owing to the nearly spherical distribution of the earth's mass, the causes of the change must almost certainly be internal. Since the angular momentum of the earth remains constant, we are reduced to the consideration of changes in the distribution of its mass, with respect to the axis of rotation. An idea of the magnitudes involved can be obtained from the supposition that

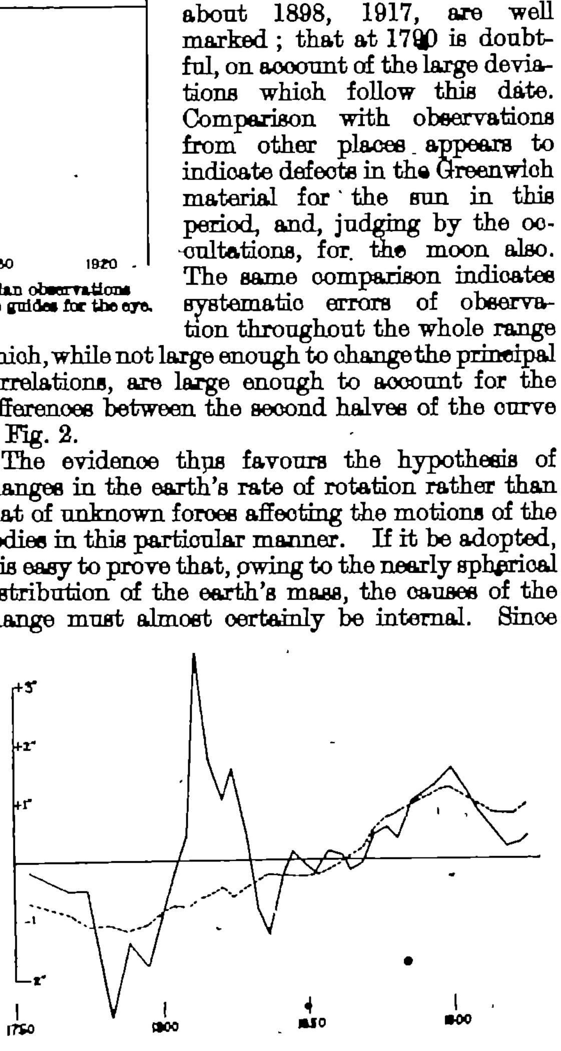

FIG 2.—Full line curve: Greenwich tabular minus observed errors of the sun, including the secular acceleration. Broken line: 1/13·3 of the lunar fluctuations.

the effects are due to successive raising and lowering of the whole crust. If the maximum change of the outer radius be twelve feet, the thickness of the crust which must be moved vertically by this amount, in order to explain the astronomical observations, is fifty miles. If uniform expansions and contractions throughout the whole earth be assumed, the maximum change of the external radius necessary is five inches. An assumption somewhere between these extreme limits appears to be the only way of explaining the fluctuations. It will be seen at once that, while local oscillations may be present, they cannot be invoked to account for the main phenomenon.

If oscillations of the whole crust take place, a natural procedure is to search for evidence of them in terrestrial phenomena. With a crust formed of uniform and unbroken material like that which composes the surface, detection would be difficult, because the resulting strains and pressures are far within the elastic limits. From the actual crust, of unequal heights, fissured in all directions and undergoing constant change from erosion, something observable may be expected. Adjustments, especially those needed for isostatic compensation, are continually taking place, and might be expected to be more frequent with or soon after a change of radius. The interpretation given here requires the earth's radius to be below its mean value from about 1790 to 1898, and a change near this latter date from the minimum to the maximum value taking taking place within a very few years, as well as a further sudden change to the mean value about 1917. Other sudden changes may have occurred in the past, but the observations lack the accuracy needed for definite statements.

Some attempts to correlate the observations with seismic phenomena have been made. Prof. H. H. Turner some years ago deduced a period of between 200 and 300 years from the records of Chinese earthquakes, and suggested that it might be related to the lunar deviations. In this connexion it must be remembered that the curve of Fig. 1 represents nearly all our present knowledge; we do not know the extent to which the period or amplitude as deduced from this curve may represent what has taken place in earlier centuries. I have attempted a comparison with the frequency of British earthquakes from the material collected by Davison in his "History of British Earthquakes." There are indications of some correlation, but as they depend partly on the curvatures at different places of the curve in Fig. 1, there is doubt as to their reality. Correlation with the intensity of volcanic action was also briefly examined without success. The records of Kilauea as gathered by Dana and others would probably have served as a test if the material had been as complete and continuous as that gathered by Dr. Jaggar since 1911.

One remarkable correlation seems to be well founded, namely, the close correspondence between the frequency of British earthquakes on one hand and the difference between the Greenwich observations and the occultations on the other. Since the occultations are gathered from observations in widely different places and are nearly free from systematic error, it would seem that the Greenwich observations are subject to a small systematic error which depends on local earth-movements. This same difference is also correlated with the lunar deviations. Closer examination of these correlations has not furnished any explanation for their occurrence.

The applications of the hypothesis, assuming that the oscillations have existed for long periods, to the formation of the surface features of the globe are far-reaching. Their source must obviously be sought in the physical and chemical conditions of the earth below the outer crust. It follows that a large supply of energy is available for external use. Adjustments to relieve the strains indirectly caused by erosion will be more frequent than without the oscillations; and the accumulated strains will be smaller. General statements of this character, however, do little more than furnish a basis for detailed investigations of specific problems. Can such oscillations, for example, constitute a factor of importance in the building of a mountain chain bordering a deep depression, as in the Pacific area? Will there be vertical or horizontal differential movements of continental areas, and, if so, can such movements be detected in variations of sea-level or of deposition of sediments? As to the latter, an inch of deposit in 200 years is 400 feet in 1,000,000 years, or 80,000 feet in 200,000,000 years, so that the magnitudes involved are of the right order for observation if the phenomenon exists. Many other questions of a similar character will occur to the geologist and the geophysicist.

The Principles of Biological Control in Economic Entomology.[1]

By Dr. R. J. TILLYARD, F.R.S., Chief of the Biological Department, Cawthron Institute, Nelson, N.Z.

I.

THE CONTROL OF INJURIOUS INSECTS.

IN considering the possibilities of success of the method of biological control of injurious insects, we have to take into account a number of factors, the most important of which are the climatic conditions and the amount of economic disturbance in the affected area. The most striking successes in control have been made in countries with a warm and equable climate, in which new beneficial insects can be introduced with greater ease and, when introduced, flourish and spread more rapidly, than in countries in which either a marked change of seasons or a severe winter has to be faced. But this climatic factor, important as it is, must rank only second to another factor, which may be termed the *amount of disturbance* of the affected area. To illustrate this point, let me take the case of an apple orchard in Australia or New Zealand. Ecologically speaking, one is no more a part of Australia than the other is of New Zealand; both are little pieces of Old England translated to a new environment with the same plant, the apple-tree, attacked in the same manner by the same pests, codlin-moth, woolly aphis, and the rest (fortunately by no means all of them are present either in Australia or New Zealand), and the same problems of cultivation, spraying, picking, and marketing. The same is true of a dairy farm or a planted forest area of exotic pines. In all these cases, before man came on the scene, the same piece of soil presented an entirely different ecological problem, with only native plants and native animals in the picture. Thus these apple orchards, these dairy farms and forest plantations, are pieces of *disturbed country*, and the amount of disturbance might, perhaps, be mathematically expressed by a formula which would show the percentages of original plants and animals remaining on the area.

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[1] From the Trueman Wood Lecture of the Royal Society of Arts, delivered on Oct. 27, 1926.

Now the crux of the whole problem, of course, is the difference between the ecological interplay of various factors in their natural habitat and in the disturbed country. Take, for example, the case of an apple orchard in New Zealand, attacked, let us say, by the woolly aphis, *Schizoneura lanigera*. The original home of this pest was North America; in many countries it is still called 'American blight.' The pest, when studied a few years ago in New Zealand, was found to be almost unbelievably virulent, and was really threatening the continuance of the apple industry. In America, on the other hand, it has never attained anything like the same degree of severity. The more favourable climate of New Zealand is evidently one of the factors making for increased severity of the pest; but the main cause of it is clearly to be seen as arising from the incomplete balance of Nature in a piece of thoroughly disturbed country. In other words, man, after destroying the original association of plants and animals on the area, had proceeded to introduce (1) the apple tree, and (2) (unwittingly of course) the woolly aphis, without balancing this association by (3) the natural enemies of the woolly aphis in the form of parasitic and predatory insect enemies.

Let us now note carefully the effect of the scientific attempt to redress this lack of balance. The task was given to me six years ago, as the most pressing problem of the moment, when I joined the staff of the newly formed Cawthron Institute in Nelson. In the course of a visit to America, undertaken with this as one of its main objects, I found that there were three kinds of insects which attacked woolly aphis successfully enough to make them worthy of consideration. These were (1) syrphid flies of the genus Pipiza, (2) the Californian ladybird beetle *Hippodamia convergens*, and (3) the chalcidoid wasp *Aphelinus mali*. In considering which of these to introduce into New Zealand, I rejected the syrphid flies because of the abundance of allied native forms in New Zealand and their inability to make headway owing to severe parasitism from Ichneumonidæ. As regards the other two insects, all the evidence seemed to point in favour of *Hippodamia convergens*. It had a wonderful record in California and was rightly regarded as one of the most valuable of known beneficial insects. Large sums of money have been spent in rearing, collecting and distributing it, and every Californian fruit-grower is fully convinced of the benefits which it confers upon him. Opinions regarding *Aphelinus mali*, on the other hand, were not so uniformly favourable. It had already been introduced into South Africa, where it was considered to be a failure. If I had had to make a choice, the evidence would have been in favour of Hippodamia. However, I was able, through the great kindness of Dr. L. O. Howard, chief of the Bureau of Entomology at Washington, D.C., to obtain good supplies of both these insects. The results were very interesting. *Hippodamia convergens* was introduced and liberated in thousands throughout the Nelson Province, but has not since been seen or heard of. It is probable that its known habit of seeking the tops of high mountains and hibernating beneath the snow has proved its undoing, for it has failed to establish itself permanently in every country into which it has been introduced. *Aphelinus mali*, on the other hand, after being kept alive with great difficulty during the first winter in New Zealand (the period corresponding with the *summer season* in North America which it should normally have experienced), became acclimatised and increased with great rapidity and vigour in the insectaries. In the course of three or four years it was distributed in large numbers to all commercial apple orchard centres in New Zealand. The result has been that woolly aphis is now under satisfactory control in New Zealand and is no longer regarded as a serious pest. The New Zealand strain of this insect has also been sent over to various parts of Australia and is proving highly beneficial there.

As regards Australia, the conditions there are very different from those in New Zealand, but I do not wish it to be thought that biological control has no future in that great country. California is part of a great continent almost as big as Australia; yet good results have been obtained there by the method of biological control. The reason is, perhaps, that California itself is really an ecological 'island,' separated from the rest of the continent by barriers of mountain and desert. If that be so, then there is great hope of successes in Australia. First of all, the whole country is an island, both geographically and ecologically, as well as a continent. Secondly, it is made up of a large number of diverse areas separated from each other, as California is from the rest of North America, by mountain barriers or great stretches of desert. Looked at from this point of view, Western Australia, for example, should provide almost as perfect a field for biological control as New Zealand, while many parts of eastern Australia, such as the elevated apple lands of South Queensland, should be ideal for application of the same methods.

I now wish to emphasise the advantages which the biological method of control has over the chemical method. First of all, control of an insect pest by spraying or fumigation is only *annual* control, not *permanent* control, and it only extends to those areas in which it is faithfully carried out. Let there be any slackening, either in place or time, of the strict spraying schedule, and the insect pests immediately take advantage of it. Further, the cost of chemical control is a continuous annual drain on the industry, whereas the cost of biological control is a definite amount, terminating when the beneficial insect has been successfully established.

I think it would be of interest to give a short account of the principal researches in biological control of insect pests which are at present being carried out in Australia, New Zealand, and Fiji.

1. *Control of Woolly Aphis.*—The New Zealand strain of *Aphelinus mali* has been sent across to all six Australian states, and is now being reared and distributed over there. Reports indicate that success is being steadily attained in Queensland and Western Australia, while in the other States the work is not sufficiently advanced to say what the result will be.

2. *Control of Pear Leaf-Curling Midge* (*Perrisia pyri*).—Mr. David Miller, Government Entomologist of New Zealand, is now engaged on the problem of introducing beneficial parasites on this bad pest. Supplies of *P. pyri* are being forwarded by the Imperial Bureau of Entomology in London, and attempts are being made to establish species of Inostemma and Platygaster known to be present. Judging by latest reports, considerable progress is being made with the species of Platygaster, and a favourable result to this important investigation may reasonably be looked for.

3. *Control of Earwig* (*Forficula auricularia*).—This insect is a very serious pest of peach and apricot orchards in the irrigation areas of Teviot and Central Otago, New Zealand. An attempt was made to introduce the parasitic tachinid flies, *Digonochæta setipennis* and *Racodineura antiqua*, through co-operation between the Imperial Bureau of Entomology, Rothamsted Experimental Station, and the Cawthron Institute, Nelson. Considerable progress was made, but the work came to an untimely end through the long illness of Mr. H. M Altson, who had charge of the work in England. The work is now again to be taken up, and the experience gained in the previous attempt should be of great value in this very difficult problem. One great advantage which New Zealand possesses over America in this case is the absence of the secondary parasites of the tachinids. The most abundant of these, *Dibrachys boucheanus*, is already present at Portland, Oregon, where the earwig infestation is worst, and renders the problem almost hopeless so far as control by tachinid parasites goes.

Parenthetically, a curious illustration of the unforseen difficulties which arise in this highly specialised work may be here mentioned. The waxmoth, *Galleria mellonella*, is becoming a serious pest in New Zealand, and a request has been made that the Cawthron Institute should endeavour to introduce a natural enemy to check it. Now it so happens that the only parasite which appears to be at all promising is *Dibrachys clisiocampæ*, which is so closely allied to *Dibrachys boucheanus* that it must be kept out of New Zealand at all costs if the experiments in controlling earwigs are ever to succeed. Consequently either the fruitgrowers or the bee-keepers must be disappointed. I have no hesitation in deciding that the earwig is by far the worse pest of the two insects in question ; and so, if the waxmoth is to be controlled by its natural enemies, some species which will not attack the tachinid parasites of the earwig must be used instead of Dibrachys.

4. *Control of Oak Scale* (*Asterolecanium variolosum*).—This insect, never a serious pest in Europe, has become so abundant on British oaks in parts of New Zealand that it is actually killing them. The only known parasite is *Habrolepis dalmanni*, of which several consignments have been received at the Cawthron Institute from Dr. Howard. A large number of females were reared from the last consignment, and, if it turns out that this species is parthenogenetic, there will be a very good chance of establishing it and so checking the scale.

5. *Control of Introduced Aphids in General.*—Only one or two very rare native species of aphids are known in New Zealand, but there are a considerable number of injurious introduced species. One of the most curious gaps in the New Zealand insect fauna is the complete absence of the green lacewings or Chrysopidæ, which are such a valuable check on aphids in other parts of the world. An attempt is therefore being made by the Cawthron Institute to acclimatise these insects in New Zealand. A fine consignment of 1900 hibernating adults of an undetermined Canadian species has been received in excellent condition, through the kind offices of Mr. Gibson, the Dominion Entomologist of Canada, and Mr. Downes, the State Entomologist of British Columbia. Three generations have already been reared and a fair number have managed to survive the rather too warm winter of Nelson. There seems to be a reasonable prospect of the final establishment of this or some other similar species throughout New Zealand.

6. *Control of Pear Slug* (*larva of Eriocampoides limacina*).—This pest is bad on pear, quince, plum, cherry, and hawthorn throughout New Zealand and Tasmania, and in parts of Australia. An attempt was made to introduce from England the ichneumon parasites of the genus Perilissus. Consignments were sent to the Cawthron Institute from Rothamsted Experimental Station. Nearly two years elapsed before the insects hatched out. They were then carefully paired in special cages and liberated into an insectary containing plenty of pear slug, which they attacked with vigour. It seemed almost certain at that point that success would be attained. But, alas ! one of the unknown bionomic factors intervened, for the entire succeeding brood proved to be males, and so the race died

out. This extraordinary example of the difficulties attending this kind of research may fittingly be used as an extra argument in favour of giving the strongest encouragement to those engaged in pure entomological research. Until we know for certain the factors governing the production of single sex broods in Hymenoptera, and also far more about parthenogenesis in this order than we do at present, we may not be able to succeed with the introduction of many valuable parasitic insects into Australia and New Zealand.

7. *Control of Sheep-Maggot Flies.*—This immense problem, of the utmost importance to Australia and other sheep-raising countries, need not be dealt with at all fully here, because up to the present no satisfactory method of biological control has been discovered. Much work has been done with several well-known chalcidoid parasites of the blow-fly larvæ and pupæ, but in no case has the percentage of parasitism produced been high enough to warrant the continuance of the work. At the present time, the interesting parasitic hymenopteron *Alysia manducator* is being collected in England by Dr. J. G. Meyers for shipment to Australia, and it will be interesting to watch the progress of the attempt to acclimatise and spread this very active insect in a warmer climate and new conditions of life.

8. *Control of Coco-Nut Moth* (*Levuana irridescens*).—This very serious pest, the original home of which is still unknown, is a small zygænid moth the larva of which feeds along the midrib of the leaflets of the coco-nut palm. In the island of Viti Levu, Fiji, it increased enormously during the past ten or twenty years, until its depredations had so weakened the trees and reduced the yield of copra that the very foundations of the industry were tottering. During the past few years scientific workers have been engaged on the problem of discovering and introducing the natural enemies of species closely allied to *Levuana iridescens* from Malaya. A parasitic tachinid, *Ptychomyia remota*, has been introduced and successfully established with very promising results, and it would appear that this formidable problem is now in process of solution.

(*To be continued.*)

Whither?—a Footnote.

"*What, then, is Life? Is it . . . a . . . possibly quite unimportant by-product of natural processes, which have some other and more stupendous end in view? . . . Or, throwing humility aside, is it the only reality, . . . ?*"—J. H. Jeans, Nature, Dec. 4, 1926.

Ribbed, breathing flesh thrice often crucified!
Veined vase of Life! lo, whether for bliss or curse
A wondrous thing the wheeling universe,
Engendering thee, lifts shapen from scarred Earth's side!
Reared in primeval war of rock and tide,
Thence hither—by what wayfaring perverse!
Thy fashioning? runs it ended more than theirs,
The stars in flow that sphere from vapours wide?
How camest thou by that strange gift ungiven
To aught else earthly, the old fruit forbidden,
To know thyself, as part to glimpse a whole,
And, that within thee, clasping earth and heaven
For comrades of like faring, to—storm-ridden—
Confront, brow raised, the incognisable goal?

C. S. S.

Obituary.

Prof. A. de Quervain.

The death of Prof. A. de Quervain at the comparatively early age of forty-seven years, which occurred at Zurich on Jan. 13, is a serious loss to European meteorology. His fellow-members on the different international commissions to which he belonged will miss a colleague who had endeared himself to them by his earnest enthusiasm and by his lovable disposition.

de Quervain was born on June 15, 1879, in the Canton of Berne. After studying at Neuchâtel and Berne he went to Paris as assistant, from 1898–1902, in the Observatory at Trappes, where the late Teisserenc de Bort was developing the exploration of the upper atmosphere by means of *ballons-sondes*. This led, in 1899, to the discovery of the stratosphere. In 1901, Teisserenc de Bort made arrangements for observations with *ballons-sondes* in Russia. Prof. de Quervain was placed in charge of the work and obtained observations of temperature in the upper air both at St. Petersburg and Moscow up to heights of 10 kilometres. After leaving Trappes, de Quervain went to Strasbourg, where the results of the international investigation of the upper air were collected and published under the direction of Prof. Hergesell. de Quervain acted as secretary to the international commission, and became impressed with the advantages which would accrue if the balloons which were used for carrying the recording instruments could also be observed during their ascent, so as to give information about the upper wind. Physical difficulties in the way of making these observations for an hour or more with an ordinary theodolite had formed a practically insuperable obstacle. de Quervain overcame this difficulty by inventing, in 1905, the theodolite with the reflecting prism, which is now practically universally adopted for observations with pilot balloons: no invention has contributed more than this to our knowledge of upper wind. It was exceptionally fortunate for meteorology that de Quervain came, during these eight years, under the influence of two such pioneers in the investigation of the upper air as Teisserenc de Bort and Hergesell. They were both inspired with the conviction that the exploration must be world-wide, and themselves carried out investigations in different parts of the oceans.

Prof. de Quervain returned from Strasbourg to Zurich, where he continued his investigations of the upper air, publishing in 1908 a thoughtful contribution on cloud studies and some notes on the connexion between clouds and the actual conditions of temperature in the upper air. In 1909 he was the leader of a joint German-Swiss expedition to Greenland, and the experience which he then gained enabled him, three years later, to lead a Swiss expedition successfully across Greenland from west to east. This was the first time the interior of the country had been traversed. (A short crossing nearer the southern extremity had been made in 1888 by Nansen.) The highest point reached was 2510 metres (about 8200 feet), 260 miles from the west coast and 150 from the east coast. The scientific results of the expedition, prepared jointly by de Quervain and his companion Mercanton, were published in 1920, and constitute the observational basis of our knowledge of the meteorology of the interior of Greenland.

When the international meteorological organisation resumed its work after the War, de Quervain became a member of the Commission for Weather Telegraphy. He had a profound knowledge of the observational side of meteorology, which proved most valuable in the difficult work of extending the international exchange of observations to meet post-War conditions. He spoke frankly when he saw the risk of a wrong decision being taken, but in a way which not only convinced his colleagues, but also endeared the speaker to them.

One project dear to de Quervain's heart was the establishment of an observatory on the Jungfraujoch at a height of 3500 metres, and for this he gained the warm support of the Commission. After the recent meeting last September at Zurich, many members of the Commission went to see the observatory, but to his great regret de Quervain was too ill to lead them. Owing to his unique knowledge of clouds he was chosen to be chairman of the subcommission appointed in 1923 at the conference at Utrecht to consider the revision of the method of reporting observations of cloud and weather in the international code. Before this task could be completed he was unfortunately seized, in 1924, by an illness from which he never completely recovered. He was, however, able to be present for a short time at one of the meetings at Zurich in September 1926, when the Commission gave its approval to a new trial code based on his work and showed its warm appreciation of his services and its sympathy with him in his illness.

de Quervain's death, when it came, was quite unexpected. He is survived by his wife and four children. It is fitting to record that Mme. de Quervain, imbued with a like enthusiasm for exploration, and resolute in face of the danger and hardship, went to Angmagsalik on the east coast of Greenland in 1912 to meet her husband after his perilous journey and to accompany him on his return to Europe.

E. G.

M. M. DELAFOSSE.

WE regret to record the death, on Nov. 13, in his fifty-sixth year, of M. Maurice Delafosse, the distinguished ethnologist and authority on African languages. Maurice Delafosse was born at Sancergues (Cher) on Dec. 20, 1870. On completing the usual educational course, he became a student at the École des Langues Orientales Vivantes, where he obtained his diploma in 1894. In the following year he was appointed to the French Government service in West Africa. This was the beginning of a distinguished official career, during which he held a number of important appointments: Consul in Liberia, 1897; member of the Anglo-French Boundary Commission on the Ivory Coast-Sudan-Gold Coast Frontiers, 1903; administrative officer of the Ivory Coast; political officer of the Government at Dakur, 1915; Governor of Oubangui-Chari, 1918.

In 1918, Delafosse retired and thenceforth devoted himself to the linguistic and ethnographical studies to which he had given considerable attention throughout his official career. He became professor of native customs and languages at the École Coloniale, and of Soudanese languages at the École des Langues Orientales Vivantes. He was also appointed Membre du Conseil Supérieur des Colonies and Membre Effectif of the International Colonial Institute at Brussels, Member of the Commission de l'Esclavage at Geneva, and Director of the Institut International pour l'Étude des Langues et Civilisations Africaines. He was one of the founders of the Institut d'Ethnologie.

Delafosse was a frequent contributor to *L'Anthropologie*, *La Revue d'Ethnographie*, and other specialist periodicals, and was the author of a number of books dealing with African languages and peoples. Among these were manuals of Dahomian, Agni, Haussa, Mende, and a comparative vocabulary of more than sixty languages or dialects spoken on the Ivory Coast. His ethnographical work included studies of the Sara (Chad) and the peoples of Liberia and the frontiers of the Ivory Coast, Sudan, and Gold Coast, the Senufi, and the peoples of the Upper Niger. Of a more general character were his "Les Noirs de l'Afrique" and "Les Civilisations Négro-Africaines." He was greatly interested in the recently formed International Institute of African Cultures and Languages, of which he became joint director. His death at a comparatively early age, which was largely due to ill-health contracted during his residence in Africa, is a great loss to ethnographic and linguistic studies, not in France alone, but wherever primitive, and especially African, races are a subject of serious study.

WE regret to announce the following deaths:

Sir Digby Pigott, Controller of H.M. Stationery Office from 1877 until 1905, an authority on the birds of London, aged eighty-six years.

Prof. E. H. Rennie, professor of chemistry in the University of Adelaide, known for his work on the chemistry of Australian plant products, aged seventy-four years.

Dr. Walter Seton, secretary of University College, London, and also secretary to the Ramsay Memorial Fellowship Fund established in memory of the late Sir William Ramsay, on Jan. 26, aged forty-four years.

News and Views.

In his article elsewhere in this issue (p. 200), Prof. E. W. Brown makes out a strong case for the belief that the chief outstanding anomalies in the motions of the moon, the sun, and the inner planets are due to errors in time-keeping arising from variations in the earth's rate of rotation. A set of the most puzzling departures of astronomical observation from gravitational theory has therefore been brought into harmony. The ratio of the chief inequalities in the longitudes of the sun and moon is such as to indicate that the variations of the rate of rotation are not associated with any corresponding transfer of angular momentum to the moon's orbital motion, and therefore Prof. Brown attributes them to changes in the earth's moment of inertia. Symmetrical swellings and contractions of the earth would certainly give rise to effects of the type observed. But elastic vibrations of the earth of this type would have periods of the order of minutes, not years, and it is difficult to think of any geological or seismological process that could give simultaneous expansion or contraction over the whole earth. An alternative explanation resting on a phenomenon already known to occur may be found in variations of the thickness of the polar ice-caps. Partial melting of the polar ice and redistribution of the water over the ocean would give changes of the moment of inertia such as are required, and the amount does not seem prohibitive. A small secular increase in the amount of ice would also give a secular acceleration of the earth's rotation, which would go some way towards explaining the outstanding discrepancy between theory and observation with respect to the ratio of the secular accelerations of the sun and moon. There is evidence of a warm climate in Europe about 2000 B.C., which would fit this suggestion.

A committee consisting of representatives of the Royal Society, the Royal Colleges of Physicians and Surgeons, the Royal Society of Medicine, the British Medical Association, the universities, and other institutions interested, has been formed to organise a celebration in London of the centenary of the birth of Lord Lister, which falls on April 5 next. Representatives of learned societies, universities, and medical bodies in Great Britain, and delegates from the Dominions and principal foreign countries, will be present. The delegates will be received by H.M. the King at Buckingham Palace on Monday, April 4. The programme so far arranged is as follows: April 5.—Reception and short addresses by some of the delegates in the large hall of the British Medical Association; conversazione at the Royal College of Surgeons of England: dinner given by the Merchant Taylors' Company, of which Lister was a member. Apr. 6.—Memorial service in Westminster Abbey, and an address by the Bishop of Birmingham; discourses in the Robert Barnes Hall of the Royal Society of Medicine on "Lister as Physiologist, Pathologist, and Surgeon," by Sir Charles Sherrington, Prof. W. Bulloch, and Sir Berkeley Moynihan; and a conversazione at the rooms of the Royal Society.

Few individual acts can have had more unforeseen consequences than when Gordon Bennett sent Stanley to find Livingstone. That was in 1869. In 1875 Stanley set out on his second expedition into Africa, financed by the *New York Herald* and the *Daily Telegraph*. That same year Stanley wrote from Uganda: "Nowhere is there in all the pagan world a more promising field for a mission than Uganda." The challenge thus thrown down was taken up by the Church Missionary Society, which has just been celebrating the jubilee of the Uganda Mission. To-day the church in Uganda has a membership of 165,000 baptized Christians, while one of the important industries of the country, namely, cotton growing, was due to a missionary. At the celebration, in which the Archbishop of Canterbury, Lord Burnham, and other distinguished men took part, it was announced that a tablet to the memory of Stanley is to be erected in St. Bride's Church, Fleet Street, one of the inscriptions to read: "To the Glory of God. In memory of Sir Henry Morton Stanley, Bula Matari (Rock Breaker), Explorer, Author, Newspaper Correspondent. 1841–1904. Challenged the Christian Church to Evangelise Uganda. 'Here is your opportunity: embrace it.'"

On Feb. 8 occurs the bicentenary of the birth of Jean André De Luc, F.R.S., the Swiss physicist and geologist who for more than forty years was reader to Queen Charlotte, consort of George III. Born in Geneva in 1727, he was well educated and took up a business career. Having a taste for study, however, he worked at meteorology and geology and made excursions among the Alps. In 1773 he came to England, and it was apparently the publication of his "Recherches sur l'Atmosphere," published the previous year, which gained him admittance to scientific circles. He afterwards made tours on the Continent, but England was his permanent home, and he died at Windsor in 1817. In physics, De Luc is credited, among other things, with noting that when a mixture of ice and water is melted the temperature remains constant until all the ice is melted. It was for his writings on geology he was principally known, and though these, to-day, are only consulted by the curious who, as Geikie said, have "leisure and inclination to dig among the cemeteries of geological literature," De Luc's devotion to science was lifelong and sincere. His "Lettres Physiques" of 1778 contains one of the earliest examples of the use of the word 'geology' in its modern sense. He is frequently mentioned in the memoirs of the time, such as Madame D'Arblay's; it is to him Watt speaks his mind about the water controversy, while Queen Charlotte refers to him as the "good old De Luc."

In an article on electrification and the Electricity Act in the *Quarterly Review* for January, Sir Charles Bright makes a strong plea for electrical progress. He points out that industrial success is largely based on the possession of an abundant supply of cheap and efficient power. He thinks that too much stress is often laid on having great hydro-electric resources. Although America's potential resources in water power are enormous, the bulk of its electricity is produced by coal. The compact nature of the load in England makes it an ideal country for the development of electrical power. In Germany, brown coal production is rapidly outstripping the production of black coal. There seems no reason why peat, of which he declares we have a superabundance, should not be similarly employed by us. If conservatism and a narrow care for established interests should hamper the future wide electrification of Great Britain, the generations to come are sure to suffer from our shortsightedness. The Electricity Act gives us a great opportunity of increasing our industrial efficiency. The technical work will be in the hands of the Electricity Commissioners. The Central Electricity Board, of which Sir Andrew Duncan is the chairman, will be concerned merely with administration; its functions will be very similar to that of a board of directors. It seems certain that the successful working of the scheme will add to the national well-being, and useful constructive criticism will help greatly towards this end.

A LARGE and representative meeting of British botanists was held at the Linnean Society's rooms on Thursday, Jan. 27, to initiate arrangements for the fifth International Botanical Congress, which is to be held in England in 1930. Dr. A. B. Rendle, who presided, announced the acceptance of the invitation extended to the botanists meeting at Ithaca last August on the occasion of the fourth Congress, to meet in Great Britain in 1930. The meeting having constituted itself a general committee, it was decided that the coming Congress should deal with pure botany only, applied sciences such as agronomy, forestry, horticulture, and pharmacognosy being excluded. An executive committee was appointed as follows: Sir David Prain, Prof. A. C. Seward, Prof. A. G. Tansley, Prof. V. H. Blackman, Prof. W. Neilson Jones, Prof. Walter Stiles, Prof. Dame Helen Gwynne-Vaughan, Dr. A. W. Hill, Dr. A. B. Rendle, and Mr. F. T. Brooks. The committee was empowered to add to its number as might be found advisable.

AN earthquake, that must have been of great strength near its origin, was felt in the eastern and north-eastern counties of Scotland at about 5.20 A.M. on Jan. 24. The disturbed area includes the Orkneys, the counties of Caithness, Nairn, Elgin, Banff, Aberdeen, Kincardine, Forfar and Fife, and at least the eastern half of Perthshire. The boundary, so far as it can be traced from the early reports, is a nearly north-and-south line concave towards the east, and therefore pointing to an origin outside the country and either in the south of Norway or just west of the Norwegian coast. At the same hour it appears that an earthquake was felt over a large part of southern Norway, and there can be little doubt that this shock was connected with the tremors felt in Great Britain. As the shock reached an intensity of 6 (Rossi-Forel scale) at Banff and Aberdeen, and 5 at Kirkwall and at Ladybank in Fifeshire, it is probabl that later reports will show that the earthquake wa felt over the greater part of Scotland and possibl in the extreme north of England. It was recorde by seismographs in the observatories of Edinburg and Kew. In Morayshire and Nairnshire an earlie shock was felt at 11.5 P.M. on Jan. 23. It is wort recalling that on previous occasions—for example, o Mar. 9, 1866, and Jan. 4, 1879—Norwegian eart quakes were felt in Great Britain, but never befor so far as known, over so wide an area.

AT a meeting of the Newcomen Society, held a the Science Museum on Jan. 26, Mr. A. Titley read paper on Trevithick and Rastrick, and the singl acting expansive engine. About a year ago an ol note-book, dated 1813, belonging to Rastrick, cam to light. This contained sketches, dimensions, an calculations regarding a 6-H.P. engine, but a grea many dimensions were given in cipher. Mr. Title found the clue to the cipher, and from the note-boo was able to make working drawings. The engine however, proved to be very like the Trevithick engin preserved in the Science Museum, South Kensingtor which was built under the patent of 1802 of Trevithic and Vivian, and is evidence of the close co-operatio of Trevithick and Rastrick. At the same meetin Mr. Jenkins was able to announce that during search by Mr. Watkin of the archives of Dartmout deeds bearing the signature of Thomas Newcomen ha been discovered. These are the only specimens, i England, of the inventor's handwriting, and they g far to establish the authenticity of a letter of New comen's preserved in Berlin.

PROF. A. S. EDDINGTON, in his second Giffor Lecture in the University of Edinburgh on Friday Jan. 28, considered certain problems of time and spac He said that two distinct questions arise: first, wha is the true nature of time? and secondly, what is th nature of that quantity which has, under the name c 'time,' become one of the main foundations of th whole scheme of experimental and theoretical science As physicists we are interested in the latter quantity and this turns out to be relative and is mixed up wit space. Einstein's theory, having cleared up thi point, was able to approach the first question, an was able to rediscover—not in the three-dimensiona but in the four-dimensional world—the time which w feel is essentially distinct from space. This is calle 'interval,' because the vested interests have otherwis appropriated the name 'time.' We have every righ to object in the name of common sense to a confusio of two things so obviously distinct as space and tim but that means we must abandon the partiall unsuccessful attempt made in classical physics t divide them, and go into the four-dimensional worl where we can make a more satisfactory separation o them.

VIEWING the world, said Prof. Eddington, we se distant events happening 'now,' and this has led u to conceive an instant 'now' not confined to 'here but spread through all space, so that we regard th enduring world as stratified—composed of a succession of world-wide instants. This conception ought to have died in 1667, when it was discovered that light takes time to travel; it is not the event but the seeing of the event which is 'now.' The idea of world-wide instants is firmly rooted, however, and the scheme has to be patched up by placing these distant events in some past instant. But the construction of the world-wide 'now' became a matter of artificial calculation, and it turned out that the resulting construction was different for observers with different notions, so that 'now' relative to one was not 'now' relative to another. The absolute structure of the enduring world contains nothing corresponding to world-wide instants; it is not stratified. The physical nature of the world is seen more clearly and simply when this stratification, arbitrarily imposed, is removed—it appears simpler though less familiar.

The third assembly of the International Federation of Intellectual Unions met at Vienna on Oct. 18, 19, and 20, 1926. A report which has reached us in multiplex typescript includes a cordial invitation to more active participation by British intellectuals. The Federation originated as a post-War French-Austrian *rapprochement*. The Vienna assembly has endorsed, and carried forward, the resolutions of an earlier assembly at Milan. Some preliminary contacts have already been made with the P.E.N. Club, the English League of Nations Union, the Carnegie Foundation, the Institut International Intermédiaire in Holland, the Institute of International Education in New York, and the Intellectual Relations Committee of the Société des Nations. Other countries are forming 'intellectual unions,' and those who seek the co-operation of Great Britain are a little baffled by the absence of any general British Intellectual Union, and inquire as to the possibility of starting one. Communications would also be welcomed from North America, Latin America, Americans travelling in Europe, and Soviet Russia.

The secretary of the International Federation of Intellectual Unions is Prince Charles de Rohan, Schloss Albrechtsburg, Post Loosdorf, bei Melk, Lower Austria. The most general object of the Federation is the supra-national organisation of Europe on an intellectual rather than on a political basis. It is assumed that the success of the more general conversations on peace, reconciliation, and fellowship now justifies the organisation of co-operative work. The programme includes the promotion of lectures in other countries by representative exponents of their own national cultures (thus, Rabindhranath Tagore has lectured in Italy), the discussion of some of the general problems of the evolution of civilisation, the arrangement of 'passeports intellectuels' or personal introductions for savants travelling abroad, and the planning of family hospitality for younger students. There is a proposal for a European press agency exchanging magazine articles and promoting the translation of new and significant works into various languages. Already on an independent business footing there is *L'Europäische Revue*, published in Leipzig. For some words like 'nation' and 'democracy,' which have different implications in French and German leading to continual misunderstandings, it is proposed to prepare a special dictionary.

The Federation complies with one of the conditions of permanence in public international organisations; it offers an open door and a warm welcome, but should be on its guard against not impossible risks of intellectual snobbishness. It is already difficult enough to try to interest socialists in international scientific societies, which are felt to be bourgeois. It is not so clear whether the Federation satisfies a second condition, that of definite purposes clearly laid down in articles of association. At the moment there is an impressive imprecision. But whatever form the political organisation of Europe may take, there is a place for thinking organisations exploring the way to the future far in advance of what statesmen call practical politics.

In his presidential address to the Indian Science Congress which met recently at Lahore, Sir J. C. Bose briefly summarised the results of his many years of research on the physiology of movement and irritability in plants. He dwelt upon the important conclusion that the physiological mechanism of the plant is essentially similar to that of the animal: in both there are contractile, rhythmic, and nervous tissues. In particular he expressed his conviction that the 'automatic' or 'spontaneous' movements of plants are to be attributed not to 'internal stimuli' but to the accumulated energy of stimuli acting from without. He concluded by pointing out how, by the gradual evolution of will, it has become possible for man to control the action of, and his response to, external stimulation, so that he is now no longer merely a passive subject of his environment.

A committee has recently been formed in Paris to raise funds for the erection of a monument to the memory of the famous French engineer, Gustave Alexandre Eiffel, the builder of the Eiffel Tower. Born in Dijon on Dec. 15, 1832, Eiffel was trained as a civil engineer at the École Centrale des Arts et Métiers in Paris and became known as a great bridge builder. The contract for the tower which formed such a feature of the International Exposition of 1889 was signed in Jan. 1887, and the full height was reached on Mar. 13, 1889. The steel lattice work reaches a height of 984 feet, 580 higher than St. Paul's Cathedral in London. It has served many purposes, and during the War proved invaluable as an anti-aircraft station, while General Ferrie, the Inspector of Military Telegraphs, said that as a radio station the tower served so many purposes that if it had not existed it would have been necessary to build it. Eiffel died on Dec. 28, 1923, at the age of ninety-one years.

In a pamphlet entitled "The Present Status of the Wild-Fowl of Europe," Dr. P. R. Lowe, of the British

Museum (Natural History), presents the case for further legislation for the increased protection of wild-duck (including swans and geese) and waders (plover, snipe, curlew, woodcock, sandpiper, etc.) in Great Britain and Ireland. Exploitation of these birds for commercial and other purposes in Europe has increased to such an extent that the rate of destruction exceeds the rate of reproduction. The position has become so serious as to cause the Swedish Government to move in the matter and to suggest international regulations for the more effectual protection of wild-fowl on migration. A committee was appointed at the International Ornithological Congress held at Copenhagen last May to consider the proposals of the Swedish Government, and a resolution was submitted to the General Congress, and passed, supporting the proposal for an international conference and asking delegates to prepare reports dealing with the facts as they affected their own countries. These reports will be considered at the International Congress which it is hoped to hold before the end of the present year. Dr. Lowe's report represents the British case, and deserves the careful consideration of ornithologists. While it appears from Dr. Lowe's detailed analysis that the situation in Great Britain is less serious than in other European countries, it is made abundantly clear that international co-operation is called for if European ducks and waders are to be saved from a steadily approaching doom.

In order to mark the end of the fiftieth year of publication the *Chemiker-Zeitung* has published a special jubilee number (Dec. 29). The issue contains many messages of appreciation from eminent technologists and from distinguished foreigners. Amongst the latter we note the names of Profs. E. Cohen of Utrecht, Mme. Curie of Paris, G. Georgevics and J. Stoklasa of Prague, A. E. Holleman of Amsterdam, W. A. Noyes of Illinois, F. Ullmann of Geneva, and R. Wegscheider of Vienna. Articles of special interest are contributed by many well-known authorities. Prof. Ostwald writes on the future of chemistry in Germany, Prof. Oppenheimer of Berlin on enzyme oxidations, Prof. E. Laqueur of Amsterdam on the three hormones, thyroxin, insulin, and menformone, Dr. A. Weinberg and Prof. F. Mayer on different aspects of the dyestuff industry, Dr. Bergius on the utilisation of coal, etc. Several contributions by prominent authorities, including one by Prof. H. E. Armstrong, are to follow shortly.

The *Chemiker-Zeitung*, which is well known not only throughout Germany but also in other countries, has rendered important service to the rapid development of industrial chemistry, both by reason of its valuable survey of scientific and technological progress and by the wide publicity of its advertising columns. Founded in 1876 by the bold enterprise of Dr. G. Krause in his native town of Cothen, it rapidly achieved success. The first four-page 'specimen-number' was published on Dec. 4, 1876; on Jan. 5 in the following year the first part of Volume 1 duly appeared, and before 1882 two weekly parts began to be issued. After passing through some critical periods, drastic changes were made in 1906. Publication was then handed over to the firm of Otto von Halem and the editorship to Baron von Vietinghoff-Scheel. On the resignation of the latter in 1918, Dr. Walther Roth was appointed editor-in-chief. In 1920 the usefulness of the journal was increased by the creation of a special section, entitled *Die chemische Praxis*, which is soon to be enlarged. The annual reports on progress, which in some form or other have always been a feature of this newspaper, will henceforth appear as a special quarterly issue entitled ***Fortschrittsberichte der Chemiker-Zeitung über die wichtigsten Gebiete der Chemie und chemischen Industrie.***

In making a plea for the adoption, especially in scientific communications, of the metric units, Prof. R. A. Gortner, of the University of Minnesota, refers in particular to the following expression used by Messrs. H. J. Page and W. Williams, of Rothamsted Experimental Station: "The land is typical strong wheat and bean land which can ordinarily be expected to give a yield of four to five quarters of wheat per acre" (*Jour. Agric. Sci.*, vol. 16, part 4, pp. 551-573). Prof. Gortner was unable to discover exactly how much a 'quarter of wheat' signified. Reference to "Webster's New International Dictionary" shows that 1 quarter, as applied to grain, is equivalent to 8 bushels. In annuals, almanacks, and in books of tables such as the "Smithsonian Physical Tables," the quarter is also defined as equal to 8 bushels. The "Encyclopædia Britannica," under "Acreage and Yield of British Crops," supplies the additional information that the imperial quarter is 480 lb. of wheat, so that the imperial bushel is the same as that in use in the United States, namely, 60 lb. of wheat. Mr. Page has also informed us that in "Recueil decoefficients et d'équivalences," published by the International Institute of Agriculture at Rome, where the metric equivalents are given of all weights and measures, it is stated that 1 quarter = 8 bushels = 2·90942 hectolitres, and that 1 quarter of wheat = 480 livres = 2·17724 quintals. Conversion tables are also available in the "Smithsonian Physical Tables." Mr. Page defends his original expression, stating that the information conveyed thereby is agricultural rather than scientific, and as such is more intelligible to those familiar with British agricultural conditions in its present form. For others, the conversion tables available must suffice while the present unscientific system of British weights and measures remains in common use.

The paper by P. Dunsheath on 33,000-volt cables, which was read to the Institution of Electrical Engineers on Jan. 20, discusses a question which is of the greatest interest at the present time. It is well known that the ordinary high-tension cables for three-phase working, each of which contains three conductors, have in several cases broken down with consequent financial loss and interference with the continuity of supply. This breakdown is generally attributed to air spaces developing in the insulating material. As the electrostatic field is very strong, these spaces get ionised, and this results in the slow destruction and ultimate breakdown of the insulating material. To get over this difficulty, cables are often made with metal sheaths wound round each of the conductors. This makes the electrostatic field in the neighbourhood of the conductors radial to them, and the insulating material has greater strength to resist radial stresses than to resist tangential stresses. The assumption is made that the tangential stress is the dangerous one. We do not think this reasoning is very convincing. Approximate expressions for the electrostatic forces inside a three-core cable can easily be obtained, and they show that the tangential stresses are small. The calculations of the sheath losses, by calculating the tangential and radial eddies separately, may be true, but it wants a more rigorous proof. The experimental results given are of value. It is stated that the introduction of metal sheaths round the conductors enables them to get rid of their heat more readily and thus enables them to carry greater currents. Assuming that the same quantity of insulating material is used in the two cases, this may be true, but the increase due to this cause would be very small.

THE numerous problems that arise in connexion with the working of oil-fields have been studied closely by electricians for many years. About twenty-five years ago the South Russian oil-fields at Baku used electric power. Now practically all the important oil-fields in the world are electrified. An interesting account of several of these installations is given in *A.E.G. Progress* for October, which is published by the Allgemeine Elektricitäts-Gesellschaft of Berlin. The main advantages in electric driving are the saving of the fuel effected and the large reduction in the working costs. Other advantages are that there are fewer breakdowns and that the cost of the necessary mechanical equipment is appreciably reduced owing to the even turning moment of the electric motor. Two years ago the A.E.G. secured the contract for the 25,000 H.P. station required for the Comodoro Rivadavia oil-fields in the Argentine. Careful calculations were made to find out whether Diesel engines, working with either gas or oil, or steam turbines would be the more economical. It was proved conclusively that the turbine scheme was the more desirable, and this has now been completed. The drawbacks to the Diesel scheme were its high capital cost and the high depreciation and interest charges. In addition, there were the higher maintenance costs and a more expensive fuel consumption when the station had only a partial load. The turbines are supplied by water-tube boilers heated by gas- and oil-firing. It is noteworthy that the air required for cooling the generators and ventilating the engine-room passes through special oil-mesh filters. The air in the engine-room is always at a definite pressure above that of the air outside, so that dusty or sandy air, which owing to the nature of the site has to be specially considered, cannot penetrate into the engine-room through the doors and windows. Accounts are also given in this paper of the Baku naphtha industry and of the Roumanian and Galician oil-fields.

THE Department of Scientific and Industrial Research has just issued the Report of the Fuel Research Board for the year 1925 (London, H.M.S.O.; 1*s*. 3*d*. net), including the report of the Director of Fuel Research. At the present time it seems a somewhat belated document, but is interesting as showing the wide range of problems which this organisation touches upon. The experiences with the vertical metal retorts for low temperature carbonisation show that such a problem is largely metallurgical, namely, the production of a cast iron not given to 'growing' at a dull red heat. Considerable space is devoted to the history of and progress made with the Physical and Chemical Survey of Natural Coal Resources, which is rightly regarded as of prime importance to the scientific use of coal in Great Britain, and to the promotion of the export trade, in connexion with which the standardisation of methods of sampling and analysis is also valuable. A memorandum of the Director prepared for the Royal Coal Commission gives an interesting survey of the fuel problem of Great Britain in its general form.

NUMBER 5 of the *Transactions of the Optical Society* for 1925–26 contains Prof. von Rohr's account of the position of the optical industry at the beginning of the nineteenth century and of Fraunhofer's optical work in the early years of the century. Mr. D. Baxandall adds some interesting facts about the ancient glass works at Ratcliff, near the Royal Mint, and the difficulties of Dolland and of Ramsden, his son-in-law, in obtaining optical glass after the closure of those works. At the beginning of the nineteenth century the best instruments appear to have been produced by the English makers, and Voigtlander, before establishing his works in Vienna in 1808, spent some years with London masters. Fraunhofer was engaged as a journeyman optician by a Munich firm in 1807 and by 1809 had attained a directorship of the firm. He aimed at scientific accuracy in his instruments, and found it necessary to learn glass-making himself. By 1813 he had made sufficiently accurate measurements of the dispersion of the glasses available and could calculate the details of an objective so that the grinder had merely to work to data supplied. He also improved the homogeneity of his glasses by having large meltings, and devised grinding and polishing machines and methods of testing his surfaces. Details of some of his instruments are given.

PROF. HENRY E. ARMSTRONG will deliver the Horace Brown Memorial Lecture of the Institute of Brewing in the lecture theatre of the Institution of Electrical Engineers at 8.15 P.M. on Friday, Feb. 25. The Horace Brown Medal will be presented to Prof. Armstrong during the course of the evening.

MR. E. GUY DAWBER, president of the Royal Institute of British Architects, Sir John Reith, managing director, British Broadcasting Corporation, and Prof. G. I. Taylor, Yarrow research professor of the Royal Society, have been elected members of the Athenæum Club under Rule II., which provides for election by the Committee of "persons of distinguished eminence in science, literature, or the arts, or for public services."

THE International Hydrographic Bureau, Monaco, has issued a Circular-Letter (No. 38-H of 1926) upon international uniformity in quarantine signals for ships, the outcome of proposals submitted to the International Sanitary Conference at Paris in May 1926. It is proposed (1) that the colour *yellow* shall be used exclusively for quarantine; (2) that international code flags Q, I, and L shall be used to signify respectively "I have a clean bill of health," "I have not a clean bill of health," "I have (or have had) dangerous infectious disease on board." Another proposal suggests the use of particular lights in definite arrangement for night use. The Directing Committee of the Bureau urges the adoption of these proposals by all governments; the signals are already in very general use.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A professor of bacteriology in the University of Cairo—Sir H. J. Waring, 37 Wimpole Street, W.1 (Feb. 11). A lecturer in physics and mathematics in the Portsmouth Municipal College—The Secretary, Offices for Higher Education, Municipal College, Portsmouth (Feb. 15). An assistant in the Bradford Natural History Museum—The Town Clerk, Town Hall, Bradford (Feb. 17). An instructress in dairying and poultry-keeping under the Agricultural Education Sub-Committee of the Herefordshire County Council—The Organiser of Agricultural Education, Agricultural Education Office, High Town, Hereford (Feb. 19). An assistant inspector in the Department of Fisheries, Irish Free State—The Secretary, Civil Service Commission, 33 St. Stephen's Green, Dublin (Feb. 19). A professor of education in Victoria University College, Wellington, New Zealand—The High Commissioner for New Zealand, 415 Strand, W.C.2 (March 1).

Our Astronomical Column.

COMETS.—Another new comet, 1927 *b*, is reported from South Africa. It is of the eighth magnitude and was found by Mr. William Reid, of Cape Town, Jan. $26^{d}\ 19^{h}\ 43^{m}{\cdot}5$ U.T. in R.A. $22^{h}\ 30^{m}\ 40^{s}$, S. Decl. 57° 49′, daily motion $+44^{s}$, S. 4′.

This is Mr. Reid's sixth cometary discovery, in addition to his detection of d'Arrest's periodic comet in 1923. He has lately been in poor health, so astronomers will be glad of this evidence of his ability to resume observing.

We are already assured of four perihelion passages in 1927 (Neujmin, Blathwayt, Comas Sola, Reid, assuming that it did not pass perihelion last year). There is little doubt that comets Grigg-Skjellerup and Pons-Winnecke will be added to the list in a month or two.

M. J. Polak has just published his definitive orbit of comet 1893 I. Brooks in the *Annals of Moscow Observatory*, vol. 8, No. 1. The comet was observed from Nov. 19, 1892, until Mar. 11, 1893. The following hyperbolic orbit was found:

$$\begin{array}{rl}
T = & 1893 \text{ Jan. } 6{\cdot}52847 \text{ Berlin M.T.} \\
\omega = & \left.\begin{array}{l} 85^\circ\ 13'\ \ 5{\cdot}4'' \\ 185\ \ 39\ \ 16{\cdot}6 \\ 143\ \ 51\ \ 28{\cdot}3 \end{array}\right\} 1893{\cdot}0 \\
\log q = & 0{\cdot}077436 \\
e = & 1{\cdot}001586
\end{array}$$

(with Ω and i on the second and third lines of the bracketed group)

The residuals with a parabolic orbit are not very much greater than those with the hyperbolic one, so the departure from a parabola is not quite demonstrated.

SOLAR RADIATION.—In *Smithsonian Miscellaneous Collections*, vol. 78, No. 5, Dr. C. G. Abbot answers criticisms advanced by Moll, Burger, and Van der Bilt (*Bulletin of the Astronomical Institutes of the Netherlands*, No. 91, 1925) with respect to his investigations on the distribution of energy over the sun's disc. The observations were made primarily for the purpose of testing the suspected variability of the solar radiation, and only differential accuracy was required. Abbot proceeds to show that even as regards absolute values the errors of the drift-curves do not exceed 0·3 per cent. at a distance of 0·95 of the sun's radius. Observations were not carried nearer the limb because of inherent difficulties, and also because they were not required for his immediate purpose. He points out that his critics' statement regarding accidental error rests on one curve made at Washington prior to 1908, though the work went on under highly satisfactory conditions at Mt. Wilson from 1913 until 1920. Abbot considers, therefore, that the Dutch investigators have drawn a too hasty conclusion in criticism of his results, and suggests ways in which two independent investigations might give different results unless certain observational details are made strictly comparable. He also mentions that, whereas he used a solar image of 40 cm. and 20 cm. in diameter, the Dutch observers used one of only 3 cm. Possibly further experiments proposed by the latter may clear away the discrepancies.

STATISTICAL PROPERTIES OF GALACTIC CEPHEIDS.—In the *Astrophysical Journal*, vol. 64, p. 149, J. Schilt discusses the proper motions, periods, and magnitudes of the Cepheid variables, and their galactic distribution. In the Sagittarius-Aquila region the period of maximum frequency is about 7 days, but in the remaining regions it is considerably shorter. The portion of the galaxy directly opposite the Sagittarius-Aquila region possesses comparatively few Cepheids, and the frequency curve of periods shows no decided maximum. There is, however, a slight indication of a maximum at an even shorter period (about 4½ days), in which case this region would closely resemble the small Magellanic cloud. Results based on the data at present available seem to indicate a discontinuity in the absolute magnitudes and other characteristics of Cepheids, at the stage corresponding to a period of about 10 days. This suggests the division of the Cepheids into two classes; but the data are too uncertain to warrant any definite pronouncement, and attention is directed to the urgent need for additional work on radial velocities and proper motions. This necessity is further emphasised by the considerable discrepancy which exists between the absolute magnitudes of Cepheids deduced from the parallactic motions of 13 Boss stars and from the motions of 28 fainter stars. The mean absolute magnitude of the former is −2·5, and of the latter +1·3.

Research Items.

Colour Selection among Negroes in the United States.—An interesting investigation in sexual selection among negroes in the United States has been carried out by Mr. Melville J. Herskovits, who describes his results in vol. 12, No. 10, of the *Proceedings of the National Academy of Sciences of the United States*. It appears that a definite type of selection, based largely on skin colour, is practised by American negroes in many aspects of their life, but especially in marriage. Students who were being measured at Howard University were asked to state whether their mother or father was the lighter. In 30·3 per cent. of the cases the father was the lighter, in 13·2 per cent. the parents were about the same, and in 56·5 per cent. the mother was the lighter. Later 400 negro families were measured in the Harlem District of New York City. Of 176 married couples available for this investigation, 29·0 per cent. showed a lighter father, 14·5 per cent. the same colour in both parents, and 56·5 per cent. a lighter mother. Further analysis shows that the men who are party to the matings are darker than the females, though in unselected series of males and females there is practically no sex difference in colour. It would therefore appear beyond question that there is a social selection in operation through the tendency of males to marry lighter females. Selection on the basis of other negroid traits, thick lips or broad noses, does not appear to be operative. If this selection on the basis of skin colour continues, as the children of each generation will tend to be darker than the mother, the American negro population will become nearer the negro type, since the relative amount of negro blood will be increased, though there is too much Indian and white blood in it to permit reversion to the pure negro type.

A Vitrified Fort at Dunagoil, Buteshire.—Excavations carried out at a fort at Dunagoil, Buteshire, from 1913 until 1915 and again in 1919, have yet to be described in detail; but a summary of the results has been published by Mr. L. M'Lellan Mann, in the *Transactions of the Buteshire Natural History Society* for 1925. The exploration of the fort is not quite complete. Vitrified forts are so called from the fact that the rubble core of the walling has been intentionally burned to form a hard vitrified mass to which the stones of the external walls adhere, thus giving great strength and power of resistance. Such structures are almost entirely lacking in fortified sites outside Scotland, where they occur chiefly near the seashore, ranging from the Solway up to the central west Highlands and thence in a belt across country to Inverness-shire as well as on a portion of the north-east coast. Dunagoil fort is entirely pre-Roman and was occupied from about 200 B.C. until A.D. 100. It is situated on a knife-edge ridge at the south end of the island of Bute. The construction of a crescentic wall on the less precipitous side, in order to give a fairly secure platform for the habitations of the occupiers, caused an accumulation of refuse which afforded a rich harvest for the excavators. The walls of the building were some twelve feet thick. They were built in stages of two or three feet, the rubble being burned at each stage until a height of fifteen feet had been reached. The rampart probably had two parapets and the fort two entrances, protected apparently by massive timber doors held by wooden bars which, when not in use, lay in horizontal holes in the interior of the walling. The objects found, which are very fully illustrated, included stone axes, hammers, knives, anvils, and other tools of stone, saddle querns imperfectly converted into rotary querns, utensils and personal ornaments of imported soapstone and lignite, an inferior hand-made pottery, many objects of bone and antler including a peculiar pin or bodkin, square in section with ornamented sides; bracelets of jet, lignite, and glass, the last-named multicoloured, and a large variety of iron objects.

Marine Biology at the Isle of Man.—The report of the Biological Station at Port Erin, Isle of Man (fortieth annual report of the former Liverpool Marine Biology Committee, now the Oceanography Department of the University of Liverpool), drawn up by Prof. J. Johnstone, indicates satisfactory progress in all directions. The fish cultural work carried out for the Manx Government shows a good average yield of young plaice, and the lobster hatching still improves, the numbers being considerably higher than before. More than a million plaice larvæ and more than six hundred lobsterlings, besides a large number of younger stages, were liberated into the sea. In the Bio-Chemical Laboratory Mr. J. R. Bruce has completed his investigations into the seasonal variations of the gaseous metabolism of the common mussel (*Mytilus edulis*), and the results have been published in the *Biochemical Journal*. He also continues his interesting researches on the metabolism of shore-living dinoflagellates. In the appendix, Mr. A. Scott describes the plankton of the spawning ponds and its seasonal variation. Mr. H. C. Chadwick, in his "Natural History Notes," mentions the occurrence of the diatom *Rhizosolenia robusta*. This is interesting, as the usual northerly limit of this species is the English Channel. It is to be noted, however, that in the last two years this diatom has been particularly abundant in the autumn at Plymouth. Being such a large form it should be of more than usual importance for feeders on the phytoplankton. A list of publications based on work done at the Laboratory shows a number of important papers dealing with fishery problems, physiology, and natural history, and includes Prof. Johnstone's book, "A Study of the Oceans." In the introduction to the report it is stated that the Laboratory is little used by visitors in the late summer, and a glance at the list of research workers shows this very plainly. It is curious that there is not more eagerness to undertake studies in these important months.

The Flora of the Talysh.—Under the above title Mr. A. A. Grossheim, botanist of the Tiflis Botanical Gardens, has recently published an interesting volume (273 pp., 16 plates, map; text in Russian, summaries in English and in Turkish) dealing with the vegetation and flora of the little-known country at the south-western corner of the Caspian Sea. The author gives vivid and detailed descriptions of various types of vegetation, ranging from that of marshes (which harbour the endemic water nut *Trapa hyrcana* G. Wor.) to the deserts, and from lowlands forests of *Parrotia persica* and *Zelkowa carpinifolia* to the rocky, woodless, semi-desert formations of higher mountains. An analysis of the flora enables the author to arrive at some interesting conclusions as regards the history of the vegetation of the region in question. In Tertiary times the country was covered with forests of tropical character, and genera like Albizzia, Gleditchia, etc., have survived even until the present day. Later on, with the advent of a drier period and the development of a powerful centre of xerothermic flora in Persia, that flora (Hyrcanian) began to invade Talysh from the south, while about the same time an invasion began of the Mediterranean flora from the west. Further intensification of the dry and hot conditions resulted in the appearance of numerous endemic xerothermic forms, which are clearly younger than the actual autochthonous elements. The glacial period, which brought great changes to the flora and vegetation of other parts of the Caucasus, left no traces whatever in the flora of Talysh. Later influences were of little importance, and only the activity of man was responsible for the introduction with the culture of rice of a fair number of typically tropical lowland plants, which misled previous students of the flora to conclude that it is essentially sub-tropical in character, whereas it is not so. A formal division of the country into botanico-geographical districts concludes the memoir.

Field Trials with Cotton.—M. A. Bailey and T. Trought, in Technical and Scientific Service Bulletin No. 63, report on experiments conducted by the staff of the botanical section of the Egyptian Ministry of Agriculture, under the ægis of the Cotton Research Board, to determine the amount of variability that might be expected in field trials with cotton, and the technique which would best reduce the experimental error. For comparative trials, it is recommended that no paths should be left between the beds, but that adjacent ridges should be uprooted at picking time. Variety beds are best repeated ten times, while all trials should be extended over a period of at least three years. The most suitable form for the beds is that of long, narrow strips, situated along the lengths of the ridges to facilitate sowing, the area being one-fifth feddan where possible (1 feddan = 4200 sq. m. or 1·038 acres approximately). The results should be computed by the method of differences. The procedure to be followed in the event of insufficient land or seed is also dealt with. A special feature of the report is the inclusion of various frequency curves, charts, and tables, which allow of a more exhaustive analysis of the data by other workers if desired.

Juniper in Norway.—The half-yearly issue (Oct. 1926) of the *Transactions of the Royal Scottish Arboricultural Society* opens with an interesting article on "The Nordfjord of Norway," a long arm of the sea extending 60 miles eastwards from the North Sea, with several subsidiary fjords. The author, Mr. F. R. S. Balfour, treats of both the agricultural and forestry aspects of the country, showing the interdependence of the population on the two pursuits. An interesting item in this article deals with the use of the juniper, which grows into a small tree of 30 feet high, for fencing work. Fences are almost exclusively made of this wood, which lasts as long in the ground as the North American *Juniperus virginiana*. The author saw a fence erected one hundred years ago, and still perfectly serviceable.

Coal in South Australia.—The Mining Review of the South Australian Department of Mines for the half-year ending June 30, 1926, recently issued, contains an interesting summary of what is known regarding the coal and lignite resources of South Australia. Apparently the only true bituminous coal so far discovered lies at very considerable depths covered with highly water-bearing Tertiary sediments, which appear to render its economic exploitation impracticable. There are three occurrences known of sub-bituminous coal, apparently of Triassic age; this coal appears to be only of moderately good quality, the moisture as mined ranging from nearly 9 per cent. to more than 30 per cent., and the ash from more than 6 per cent. to more than 18 per cent.; a sample which has been tested gave 7460 B.Th.U. per lb. as mined, a figure which compares very unfavourably with ordinary bituminous coal. A number of occurrences of Tertiary lignite are known; apparently the only attempt at actual mining has been done in the Moorlands field, and the coal has been extensively tested, but the results do not appear to have been satisfactory. It would appear that up to the present, imported coal can be used to better economic advantage than any of the mineral fuels hitherto discovered in South Australia.

Granite Domes of Vredefort and Arran.—The recent monograph on the Vredefort Mountain Land, by Hall and Molengraaff, has aroused world-wide interest among geologists, mainly because of the wonderful and almost incredible structure of the sediments on the flanks of the granitic dome which lies in the heart of the region. The sediments have not only been heaved up but they have also been carried through the vertical and overturned. For this reason, Hall and Molengraaff rejected the idea that the structure might be due to the upward surge of magma. Their problem is further complicated by the possibility that the Vredefort granite is, in the main, older than the overtilted sediments; and their tentative conclusion is that the balance of evidence favours the conception of centripetal pressure as the cause of the dome. In the *Geological Magazine* for November, Mr. E. B. Bailey summarises the evidence, and points out in detail the striking analogies presented by the granite dome of North Arran. Although in Arran the surrounding schists are rarely overturned, the evidence is conclusive that they were powerfully uplifted by the intrusion of the granite complex, and that the upheaval was accompanied by an outward movement that succeeded in overturning a boundary of Old Red Sandstone. Mr. Bailey points out that an upward magmatic push must develop an outward centrifugal push. Combining this tectonic necessity with the evidence of its existence elsewhere, and the difficulty of imagining a mechanism to explain the suggested centripetal pressure, he strongly advocates central upheaval by upward magmatic pressure accompanied by centrifugal pressure as the explanation of the updoming and back-tilting of the formations bordering the Vredefort granite.

Physiography of the Virgin Islands.—The New York Academy of Sciences has nearly completed the publication of its detailed "Scientific Survey of Porto Rico and the Virgin Islands." One of the most recent parts to appear is vol. 4, pt. 1, which deals mainly with the physiography of the northern Virgin Islands, British and American, by Messrs. H. A. Meyerhoff and J. F. Kemp. The conclusions of most interest are those with regard to the submarine platform from which the islands arise. This has generally been accepted as due to marine erosion in Pleistocene times, when the sea-level was lowered in tropical latitudes, but Mr. Meyerhoff is convinced, after a detailed study of its features, that river action has played the chief part in its formation. He found numerous remnants of horizontal coastal plain deposits, presumably of Tertiary age, lying on the submerged platform. These are evidence of river erosion before Pleistocene time. The action of the waves in Pleistocene times was effectual, if at all, only in modifying the surface. The evidence is discussed at length in the monograph, which is well illustrated with maps, diagrams, and photographs.

Rainfall of Moravia.—Some relation between the amount of precipitation and altitude above sea-level are discussed by Dr. Fr. Rikovsky in Part 78 of *Publications de la Faculté des Sciences de l'Université Masaryk*. On the plateau of Moravia the rainfall is 530 mm. at 200 m. and increases some thirty-three millimetres for every 50 metres up to 650 m., above which the increase grows rapidly. In the eastern or drier part of the Moravian Carpathians the fall is 561 mm. at 200 m., and the increase up to 600 mm. is much more rapid than on the plateau, while at higher elevations it is much slower. The explanation is that on the Carpathians the air currents, owing to the steep slope, are forced to rise abruptly, and so lose much of their humidity at low altitudes, while on the plateau the rise is gradual and the loss of moisture steady. In the western part of the Moravian Carpathians, precipitation is much greater and increase is steady and continuous. Statistical tables and diagrams show these relationships.

Resistance of Metals at Low Temperatures.—Supplement No. 58 to the Communications from the Physical Laboratory of the University of Leyden consists of a collection of all the known data concerning the electrical resistance of metals at temperatures below −80° C. made by the late Prof. Kamerlingh Onnes and Dr. W. Tuyn. A large proportion of the data comes from the Leyden Laboratory, but in all cases references are given to the original sources. 42 pages of tables and curves are devoted to the influence of temperature, 4 to that of pressure, and 28 to those of impurities, heat treatment, and other factors. Of the large number of formulæ which have been suggested for the relation between the resistivity and the temperature only a few are noted. For monatomic metals the resistivity seems to be proportional to the product of the absolute temperature and the atomic heat at constant pressure. There is some divergence of opinion as to the validity of a law of 'corresponding resistances' which has been suggested.

Impact Tests of Steel at Low Temperatures.—Impact tests have been made by Ryonosuke Yamada (*Sci. Rep.*, Tohoku Imp. Univ., Ser. 1, vol. 15, No. 5, Nov. 1926) on a large number of steels at temperatures from that of the room down to that of liquid-air. The main results obtained are: In general the impact value falls as the temperature is lowered, though in a dead-mild steel, for example, this value actually rises down to about −40° C., when it suddenly falls to almost zero. Quenched and tempered steels, or any steels with a sorbitic structure, are much tougher at low temperatures than are pearlitic steels. The addition of nickel and chromium retards appreciably the increase of brittleness as the temperature is reduced. As the latter falls there is a progressive tendency for the fracture produced to pass around, instead of through, the crystals, and the fracture in pearlite to take place in all directions irrespective of the orientation of the lamellæ.

A New Phenomenon in the Abnormal Discharge.—When the distance between the electrodes is decreased in a tube in which a normal discharge is passing, the potential difference between the electrodes gradually decreases, until the anode approaches so close to the cathode inside the Faraday dark space that some of the fast primary electrons from the cathode reach the anode, and then the potential falls somewhat rapidly. If the distance between the electrodes is still further decreased, the potential remains practically constant until the anode penetrates approximately to the middle of the negative glow, when it increases very rapidly, owing to the fact that the fast primary electrons and the secondary electrons they produce have not sufficient space in which to form considerable numbers of positive ions. In investigating this phenomena during the passage of an abnormal discharge, Guntherschulze (*Zeit. fur Phys.*, 40, 414, 1926) found that the higher the applied potential, the sharper did it fall just before the rapid increase due to the close proximity of the electrodes occurred. The cause of this phenomenon is found to be that the fast primary electrons from the cathode are able to form larger numbers of positive ions in the layer of gas and water vapour absorbed on the surface of the anode than they are able to produce in the body of the gas in the tube.

Isolation of Element 61.—In their first paper on the isolation of element 61 (see Nature, Dec. 4, 1926, p. 820, and Jan. 1, 1927, p. 27), Rolla and Fernandes stated that a sealed packet containing their results and a photograph of the X-ray absorption spectrum was sent to the Royal Academy of the Lincei so early as June 1924. In order to prove their claims to be the first to isolate the element, these preliminary results have been published in the November issue of the *Gazzetta Chimica Italiana*. Rolla and Fernandes have proposed the name 'florentium,' with symbol 'Fr,' for this element in honour of the University of Florence, where the research was carried out.

The Attempted Change of Mercury into Gold.—The News Edition of *Industrial and Engineering Chemistry*, dated Dec. 10, contains a detailed account by Sheldon and Estey, of the New York University, of attempts to change mercury into gold by the method used by Miethe. The actual type of mercury arc lamp used by Miethe, which was obtained from Germany, as well as other lamps, were used, and the experimental conditions were reproduced so far as possible. Details of several experiments are given, but in no case was any amount of gold greater than 0·005 milligrams (the limit of detectability) produced. Various deposits were produced in the lamps, but these never contained any gold, and the residual mercury was also found to be free from that metal.

Ignition Temperatures of Solid Fuels.—In connexion with the subject of spontaneous combustion, the study of the ignition temperatures of fuels is of great importance. K. Nakamura and A. Shimomura have improved the ordinary form of apparatus, and have published the relative ignition temperatures of twenty-two kinds of solid fuels, including lignites, bituminous as well as anthracite coals of oriental origin, semi-coke, metallurgical coke, and wood charcoal, in the *Memoirs of the Kyoto College of Science*, Series A, Nov. 1926. Previous work by Wheeler has been confirmed, and it has been found that volatile matter and ash-content have a decided influence on the ignition temperatures of the fuels.

Mechanism of Kolbe's Electrosynthesis.—There are two theories as to the exact nature of the change by which ethane is produced at the anode during the electrolysis of a solution of potassium acetate. According to the 'oxidation theory,' the discharged anions react with water to give the acid which is oxidised by atomic oxygen to give the synthetic product, while the 'discharged ion' theory supposes that two discharged ions unite directly. A paper in the *Journal of the Chemical Society* for Dec. 1926, by D. A. Fairweather and O. J. Walker, describes some work on solutions of acetates and propionates which was carried out in order to obtain further data bearing on electrosynthesis. The results show that the synthesis can only be accounted for on the 'discharged ion' theory.

The Technique of Vitamin Assay.

When it was found that a diet of pure protein, fat, and carbohydrate with salts and water was incapable of maintaining life in animals unless small quantities of certain natural foods were added, quantities too small to supplement the energy value or the content of the diet in the other known constituents, the foundation was laid upon which has been built in the last fifteen years a vast store of knowledge about the properties and occurrence of these unknown accessory food factors or vitamins. At first investigators were concerned with the qualitative distribution of each vitamin, as it was discovered: only later was attention directed to its quantitative estimation in different sources, as the methods of assay became more perfected. These lines of approach to an accurate knowledge are in use to-day, when a new vitamin is discovered, as is shown by the work of Evans and his collaborators on Vitamin E, or the reproductive factor.

It is obviously important from the point of view of dietetics and medicine that the amounts of the vitamins in different food and medicinal products should be accurately known. Such knowledge can be obtained at present only indirectly, since the vitamins have not yet been isolated in pure form, and any fallacies inherent in such a method of assay are greatly enhanced by the fact that, in general, living animals must be used for the test. Hence improvements in technique relate to the use of a standardised animal, bred especially for the purpose, and placed on a diet either deficient solely in the factor to be assayed, or so designed as to enable the observer to obtain a clear-cut response on the part of the animal or even of a given tissue, when the missing factor is added to the diet. Recent improvements in technique are especially noticeable in the case of Vitamin A or the growth-promoting factor, and Vitamin D or the bone-calcifying factor. A further interesting development is the use of a colour test, which can be used for the quantitative estimation of Vitamin A, and bids fair in time to replace the laborious growth test on animals altogether.

The details to be followed in the production of a standard breed of rats for the assay of the fat-soluble Vitamins A and D are discussed by H. Chick and H. H. Smith and H. Chick (*Biochem. Jour.*, 1926, vol. 20, pp. 119, 131). The authors were led to their researches by finding unexplained irregularities in the behaviour of the young rats when placed upon the standard basal diet deficient in fat-soluble vitamins. In general, better growth and calcification of the bones were found in summer and autumn than in winter and spring. Neither the degree of illumination to which the animals were exposed nor the constituents of the standard deficient diet were found to be implicated in this variability. It may perhaps be mentioned here that the diet largely used in Great Britain consists of inactivated caseinogen, starch, a hardened vegetable oil, salts and water, together with 'marmite' and lemon juice to supply Vitamins B and C respectively. The caseinogen is inactivated, *i.e.* any fat-soluble vitamins present are destroyed by heating it to 120°-130° C. for thirty-six hours.

Examination of the diet given to the stock-breeding rats, however, disclosed the possibility of serious variations in the amount of Vitamin D, with smaller changes in the case of Vitamin A, dependent upon seasonal alterations in the content of these vitamins in the fresh milk of the diet. It is well known that the store of fat-soluble vitamins in young rats depends on the previous diet of the mother, especially during pregnancy and lactation. Hence the diet of the stock animals should contain, if possible, a constant and sufficient, but not excessive, quantity of fat-soluble vitamins. This ideal was approached by replacing fresh milk with a dried winter milk towards the end of pregnancy and continuing its use during lactation, and, in the case of the young, during the period elapsing between weaning and placing on the deficient diet. Earlier use of this milk in the mother's diet lowered the store of vitamins too much, so that it became difficult to rear the young. The other constituents of the diet, bread, whole cereals and seeds, fresh raw vegetables, and marmite, with meat twice a week, provided a steady supply of Vitamin A; so that the irregularities in the young rats were probably chiefly caused by variations in their stores of Vitamin D.

The fact that the latter vitamin may be responsible for variations in growth has only recently been realised, with the definite demonstration that Vitamins A and D are distinct accessory food factors. Its importance is demonstrated by the following considerations: the original standard diet deficient in fat-soluble vitamins is deficient in both: cessation of growth may then be due to exhaustion of either, and resumption of growth, on supplementing the diet with a material containing them again to either, or both, of the vitamins present. Hence titrations of Vitamin A may be considerably affected by the presence or absence of Vitamin D from the diet or body of the experimental animal.

This question has been carefully examined by J. C. Drummond, K. H. Coward, and J. Hardy (*Biochem. Jour.*, 1925, vol. 19, p. 1068). The authors found that irradiated cholesterol, which is now known to have marked antirachitic potency, that is, to contain Vitamin D, can, under certain conditions, cause resumption of growth in rats on the standard-deficient diet. But the authors show that this does not mean that by irradiating cholesterol, Vitamin A is generated. In the first place, the colour reactions of irradiated cholesterol are not those usually associated with Vitamin A (this subject is discussed more fully below); secondly, the addition of the irradiated material to the diet only produced resumption of growth when given soon after growth had ceased; later it was without this effect; and thirdly, the resumption of growth was only temporary and could not be maintained by increasing the dose, although small doses of cod-liver oil prevented the decline in weight, in fact, allowed growth to continue. The authors conclude that the store of Vitamin A in the animal is only available in the presence of Vitamin D, and that the irradiated cholesterol supplies the latter and not the former.

Hence in comparing the growth-promoting powers of two materials, one of which contains Vitamins A and D, and the other Vitamin A only, an erroneous idea of their relative contents in Vitamin A can easily be obtained if the animals at the time are suffering from a simultaneous deficiency of Vitamin D. With the former supplement, growth would be dependent on both vitamins together; with the latter, little growth would probably be seen, unless the animals still had a store of Vitamin D, although the Vitamin A content of both materials might be the same. The important conclusion is therefore reached that for the accurate assay of Vitamin A, Vitamin D must be always present in the basal diet. This can be ensured by the addition of irradiated cholesterol to the diet, or by feeding it separately as a daily supplement dissolved in liquid paraffin (Drummond *et al.*), or perhaps more conveniently by using an irradiated hardened vegetable oil as one of the constituents of the diet (H. Chick and M. H. Roscoe, *Biochem. Jour.*, 1926, vol. 20, p. 632). Drummond excludes fats altogether from his latest standard diet, replacing them with starch, but other observers continue to use a diet of the type mentioned above. If the animals are given a diet deficient only in Vitamin A, they continue growing for a longer period than when Vitamin D is also absent; but when growth ceases, a decline in weight rapidly sets in and the supplement containing Vitamin A must be quickly given, if death is to be prevented.

So far we have considered the assay of Vitamin A by means of animal experiments. The difficulties and the time involved lend importance to an alternative possible method, such as a colour test, which can be performed quickly and accurately in a test tube. Two such have been recently described as specific for Vitamin A: the transient blue colour produced by arsenious chloride (Rosenheim and Drummond) and the stable red colour produced by pyrogallol in the presence of a light petroleum solution of trichloracetic acid (W. R. Fearon, *Biochem. Jour.*, 1925, vol. 19, p. 888). The latter, which seemed likely at first to be of great use, was modified by S. G. Willimott and T. Moore (*ibid.*, 1926, vol. 20, p. 869): resorcinol was used instead of pyrogallol, and a saturated solution of benzoyl peroxide in toluene was added to hasten the reaction, the trichloracetic acid being also dissolved in this solvent.

Preliminary experiments showed that the colour was produced by those substances, chiefly oils, in which the presence of Vitamin A is generally accepted, and not by others from which this vitamin is absent. However, a more extensive study by O. Rosenheim and T. A. Webster (*Lancet*, 1926, vol. 2, p. 806) has demonstrated that the test is not specific for Vitamin A: thus, on saponification of an active oil, Vitamin A remains in the unsaponifiable fraction, but the chromogen giving Fearon's reaction passes into the soaps formed, being associated with the unsaturated fatty acids. Again, only fish liver oils give the reaction, whereas the liver oils of birds and mammals contain Vitamin A: body fat may react positively, but negatively to the arsenious chloride reagent. In a biological test, a sardine oil, giving Fearon's reaction, was found to be devoid of the growth-promoting factor, whereas pig's liver fat, although reacting negatively with Fearon's reagent, yet gave as good growth as cod-liver oil—even when only half of the dose of the latter was used. In all cases vitamin A and the colour reaction with arsenious chloride were found to occur together, in fact, the latter appeared to give a depth of colour roughly proportional to the amount of vitamin disclosed by a growth test. Hence it may be concluded that the colour given by Fearon's reagent is due to some other constituent of the oil than Vitamin A. On the other hand, the arsenious chloride reaction appears to be specific, so far as our present knowledge goes. The drawbacks to the test are the transient nature of the blue colour produced, and the fact that the reagent cannot be used with a solvent.

F. H. Carr and E. A. Price, and T. T. Cocking and E. A. Price have therefore examined a large number of other compounds with the view of selecting a more satisfactory reagent (*Biochem. Jour.*, 1926, vol. 20, p. 497; *Pharm. Jour. and Pharmacist*, 1926, vol. 107, p. 175). At first the substitution of arsenious chloride by a saturated solution of trichloracetic acid in chloroform, as suggested by Rosenheim and Drummond, gave promise of satisfying the necessary requirements, but it was found that the colour production depended on the presence of an impurity in the acid, probably phosgene. The authors finally selected a 30 per cent. solution of antimony trichloride in B. P. chloroform as the most satisfactory reagent so far found: it can be used with a 20 per cent. solution of the oil under test in chloroform, enhancing the accuracy of measuring small quantities of oil. Moreover, the blue colour lasts sufficiently long for a match to be made against the standard glasses of a Lovibond tintometer, and is not interfered with by traces of water or alcohol in the reagents. The colour formed always contains traces of yellow and sometimes also of red.

The real problem which now faces investigators is whether the colour test always gives the same value as the growth test, when both are carried out on a large number of different oils. Some preliminary experiments carried out by S. W. F. Underhill (*Biochem. Jour.*, 1926, vol. 20, p. 500) lend hope that this parallelism may be invariably found, in which case the biological assay, with its difficulties of animals and time, may be rendered unnecessary, being replaced by the much shorter and probably more accurate colour test.

The titration of Vitamin D or the bone-calcifying antirachitic factor still requires the biological method. Moreover, rickets is not produced in rats on a diet deficient only in fat-soluble vitamins. Although the bones contain less calcium than normally, the picture is one of osteoporosis, so that such a diet is not suitable for this assay (H. Chick and M. H. Roscoe, *v. sup.*). But if the diet is deficient in phosphorus also, rickets occurs. Two such diets have been widely used: one was described by Sherman and Pappenheimer, and consists of patent flour with the addition of a few salts; the other we owe to McCollum, its chief ingredients being wheat, maize, gelatin, and wheat gluten with a few added salts. Rosenheim and Webster (*Biochem. Jour.*, 1926, vol. 20, p. 537), using the former, found that sometimes the control animals failed to develop rickets and traced this irregularity to a small quantity of fat present in the patent flour, which could become 'activated' if the flour was exposed to light. They therefore recommend an extraction of the flour with ether at room temperature for a short period, before it is used in the diet.

The degree of calcification of the bones on these diets can be determined radiologically, histologically, or by chemical analysis. Improvements in the presentation of results by the last method are described by Chick and Roscoe (*Biochem. Jour.*, 1926, vol. 20, p. 137, and with V. Kovenchevsky, *ibid.*, p. 622). More clear-cut results are obtained if, in addition to the ash, the fat of the bones is also estimated. Omission of this precaution may suggest that a substance under test has improved the calcification slightly, whereas it has only reduced the fat content, possibly by improving the nutrition of the animals quite apart from its content in Vitamin D, if any is present at all. Normal bones contained about 2 per cent. of fat, rickety 4 per cent., and osteoporotic 10 per cent.: the ash content respectively was found to be 34 per cent., 11 per cent., and 25 per cent. for comparable bones. The authors suggest that the ratio of the ash to the organic residue (that is, the difference between the weight of the bone and the sum of the weights of water, fat, and mineral constituents) may give a useful index of the degree of calcification and of rickets. Normally it is about 1·5, in osteoporosis 0·9–1·2, and in rickets 0·4–0·8.

The more accurate the methods of assay, the better is our knowledge of the value of different food or medicinal products, and the greater is the hope of developing methods for the isolation of the accessory food factors in a pure form.

Tropical Cyclones of the Pacific.

By E. V. Newnham.

Reference was made in a recent article on "The Tropical Cyclone" (Nature, Oct. 9, 1926) to the need for a more complete knowledge of the meteorological conditions in the regions where these storms form, in order to test the correctness of the various theories of the origin of cyclones that have been brought forward at different times. It might have been added that our knowledge is very incomplete even as regards the frequency of their occurrence, the paths which they follow, and the length of life of individual storms, and this is particularly true for the Pacific Ocean. A new work has recently been published, which fills up a few of the gaps in our knowledge.[1] The materials for this work were collected in 1921–1922, when the author spent a year in visiting tropical Oceania and the Far East in order to gather information about cyclones at first hand from resident white officials; he also visited the Meteorological Bureau of the Australian Commonwealth and the Japanese Marine Observatory, as well as various other meteorological centres in the East, in order to study local synoptic weather charts and to discuss his subject with those who have made a special study of the cyclones of those regions.

It appears from Visher's work that, in defining the two remote eastern areas of cyclone-formation, it would have been better not to have restricted the eastward extension of those areas, for although it may be true that more cyclones occur in the western than in the eastern half of the Pacific, many undoubtedly occur near the western coasts of America both north and south of the equator; so many must occur unrecorded in the Western Pacific, unrecorded because of the small number of islands inhabited by educated white men and because of the small number of ships that pass westwards beyond American coastal waters, that an accurate estimate of their average annual number and of their distribution is at present impossible. Visher, indeed, lays great stress on the under-estimation that has been made of the number of storms over the tropics as a whole. If attention is not confined to the most violent and destructive storms, the season of cyclonic activity expands from the summer and autumn to the whole year, and, judging from those regions near the western border of the Pacific for which reasonably detailed synoptic charts are available, for example, the regions around Australia and Japan, the annual number must be very large. Of these a considerable proportion appear to pass out of the tropics, and, by the large exchange of air between tropical and temperate latitudes to which they give rise, exert a big influence upon the weather of both zones, and upon the general circulation of the atmosphere of the whole earth.

The idea that tropical cyclones are of rare occurrence appears to have been held by many meteorologists, and has probably arisen because, on the average, only a small proportion of the total area within the tropics is affected annually by winds of hurricane strength, and a large part of this proportion is open ocean traversed only occasionally by ships. In considering the exchange of air between the tropical and temperate zones, the numerous lesser systems of low pressure are probably, in the long-run at least, as important as the relatively few destructive storms. Visher gives a table of annual frequencies of recorded tropical cyclones which is reproduced here. It should be noted that, in view of the large number of storms and disturbances that are not recorded, the figures are intended as conservative estimates, much below the true totals.

Average Annual Frequencies of Recorded Tropical Cyclones and Cyclonic Disturbances.

	Severe Hurricanes.	Lesser Hurricanes and Cyclones.	Cyclonic Disturbances
Western North Pacific (110° to 140° E.) .	10	20	50
Central Pacific (140° W. to 140° E.) . .	2	4	..
Eastern North Pacific (E. of 150° W.) .	2	3	..
Western South Pacific (130° W. to 160° E.)	5	10	10
Australian Region (110° E. to 160° E.) .	5	8	10
South Indian Ocean	8	5	..
Arabian Sea	2	2	..
Bay of Bengal	2	6	> 2
North Atlantic	3	2	> 2
Totals . .	39	60	> 74

These give an annual total for all classes of cyclone of more than 173.

Two other points of particular interest that are brought out in the paper under notice are:

(1) The unexpectedly large number of cyclones that occur within 8° of the equator in the Pacific, especially in the neighbourhood of the East Indies.

(2) The apparent absence of any kind of direct relationship between the number of cyclones that occur in the Pacific and the physical state of the sun, as revealed by the number of dark spots that are visible.

With regard to the first point, two cases of cyclones originating not more than 4° from the equator in the North Indian Ocean during the period 1900–1912 have been recorded.[2] Visher was informed by T. Okada, Director of the Japanese Imperial Marine Observatory, that the meteorological conditions at Jaluit (lat. 6° 8′ N., long. 170° E.) indicate typhoons west and south-west of that island, and in a table giving particulars of the place of origin of typhoons that were first reported within 8° of the equator, Visher gives one in latitude 4° N., and several in latitude 5° N. These cases are interesting in that they show that although some deflexional effect of the earth's rotation is necessary to prevent air from flowing directly into a centre of low pressure and so filling it up, the amount need only be very small.

The second point mentioned above requires little comment. All Visher's ingenuity in handling the available statistics, so as to bring out any connexion that there may be, gives negative results. Although several earlier investigators have claimed that there is a connexion, it appears very unlikely that there is a simple direct relationship, when it is remembered that the variations of the solar 'constant' of radiation between times of sunspot maximum and minimum, if any systematic variations do in fact exist, must be very small, and the effect of a variation of the intensity of solar radiation upon terrestrial atmospheric processes is likely to be complex.

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[1] "Tropical Cyclones of the Pacific." By S. S. Visher. Bernice P. Bishop Museum. Bulletin 20, Honolulu, Hawaii. Published by the Museum, 1925.

[2] "Hurricanes and Tropical Revolving Storms." By Mrs. E. V. Newnham, Geophysical Memoir No. 19, Meteorological Office, 1922.

Another negative or almost negative result of some practical importance relates to the varying degrees of storminess experienced in different years in the Far East. Visher has studied the question as to whether unusual storminess in the early part of a storm season is an index to the probable storminess of the remaining part of that season, and finds that the storminess of June is little or no index, whereas that of July may be of some value. There seems, in general, to be some slight positive correlation between the number of cyclones in one month and the number in the remaining months of the season. This applies to the Far East as a whole, and not to one particular district. It should be noted, however, that variations in the completeness of the information about the number of storms that occur each year would give rise to a spurious positive correlation.

There are many other items of interest in this work which cannot be discussed here, among them a section on the effect of cyclones on the dispersal of life from island to island in the Pacific. The bibliography is very extensive, containing 209 references to other works and articles, and to interviews with other meteorologists.

University and Educational Intelligence.

Edinburgh.—We have already announced the gift to the University by the International Education Board of the Rockefeller Foundation of a sum of £74,000 for the purpose of assisting towards the establishment of a new Department of Zoology. Of this sum, £38,000 is set aside towards the cost of building, £10,000 is for equipment, and £26,000 for endowment. The University already had available from the gift of the late Dr. Laurence Pullar and from the Carnegie Trust a sum of £41,000 towards the cost of the building. The work will be proceeded with at once, and plans will be prepared by Sir Robert Lorimer in consultation with Prof. J. H. Ashworth. The new Department will be at the King's Buildings on the south side of the city, adjacent to the Departments of Chemistry and Geology.

London.—The Laboratory of Civil and Mechanical Engineering at University College is to be named "The Cowdray Laboratory of Civil and Mechanical Engineering," in recognition of Lord Cowdray's generous gifts, amounting to £20,000, to the Faculty of Engineering at the College.

The title of reader in geology in the University has been conferred on Mr. George McDonald Davies, in respect of the post held by him at Birkbeck College. Mr. Davies studied at Birkbeck College. From 1908 until 1920 he was assistant, and latterly senior assistant, in the Mineral Laboratory of the Imperial Institute, and from 1906–20 he held part-time posts at Birkbeck College. Since 1920 he has been head of the Department of Geology at Birkbeck College. His published work includes "Elementary Crystallography" (with Dr. J. W. Evans, 1924), "Tin Ores" (1919), and numerous papers in geological journals.

The following degrees have been conferred:—D.Sc. in botany on Miss Nesta Ferguson (King's College and Royal Holloway College) for a thesis entitled "The Aloineæ—a Cytological Study, with especial reference to the Form and Size of Chromosomes"; D.Sc. in chemistry on Mr. J. W. Cook (University College and the Sir John Cass Technical Institute) for a thesis entitled "The Reactivity of *meso*-substituted Anthracenes"; on Mr. S. B. Dutt (Imperial College (Royal College of Science)), for a thesis entitled "(1) A Theory of Colour on the Basis of Molecular Strain. The Effect of Chromophoric Superposition; (2) Ring-chain Tautomerism, Parts I. and II."; and on Mr. W. G. Shilling (East London College), for a thesis entitled "The Temperature Coefficient of the Molecular Heats of Gases"; D.Sc. in statistics on Mr. Kazutaro Yasukawa (University College), for a thesis entitled "Contributions to the Mathematical Theory of Statistics." D.Sc. (*Economics*) on Miss M. C. Buer (London School of Economics), for a thesis entitled "Health, Wealth and Population in the Early Days of the Industrial Revolution"; D.Sc. (*Engineering*) on Mr. W. D. Dye, for a theses entitled "(1) The Piezo-Electric Quartz Resonator and its Equivalent Electric Circuit; (2) A Self-contained Harmonic Wavemeter," and other papers.

A special course of seven lectures on modern developments in regard to fuel is to be delivered at the Sir John Cass Technical Institute, Jewry Street, Aldgate, London, E.C.3, on Mondays at 6 P.M., beginning on Feb. 7. The lecturers include Mr. F. S. Sinnatt on low temperature carbonisation and Prof. J. S. S. Brame on liquid fuel.

The Ellen Richards Research Prize of the value of 2000 dollars is being offered for award in 1928 "to a woman of any nation on the basis of distinguished scientific research." In countries where there is a national federation of university women this federation may appoint a committee of experts to nominate candidates. Where there is no such federation, nominations may be made by individual women holding university positions. Federations may each nominate three candidates, individuals one. Nominations must be in the hands of the committee before Jan. 15, 1928. Applications for information, circulars, or nomination forms should be sent to the secretary, Mrs. Samuel F. Clarke, Williamstown, Mass., U.S.A.

The Free Place Scholarships Examination, 1926, in the County of Kent, formed the subject of a special investigation conducted, at the request of the Education Committee, by Mr. Andrew Bell. The results of the investigation have been published in a 55-page pamphlet obtainable from the Director of Education, Springfield, Maidstone (price 1*s.* post free). The examination, which is, in Kent, controlled in each secondary school district by the school headmaster, includes—in addition to a written examination, consisting of English, arithmetic, and intelligence test, for which the maximum total marks assignable are 250—an oral test carrying, as a maximum, 100 marks. The Kent County Association of Teachers put forward as one of a series of recommendations, which led to the demand for a special inquiry, a proposal that the oral part of the examination should carry as many marks as the written examination, and one of the objects of Mr. Bell's inquiry was to determine whether this proposal should be adopted. The chapter of the report dealing with this question is of special interest in view of its bearing on the pronouncements of the Board of Education Consultative Committee in paragraph 80 of its report on psychological tests of educable capacity, wherein emphasis is very strongly laid on the value of oral interviews as a means of discovering latent ability and promise. Mr. Bell's conclusion is that in the present state of our knowledge regarding the technique of the interview, it is undesirable that the marks for the oral examination (which each headmaster has full liberty to conduct according to his own ideas) should be increased.

Calendar of Discovery and Invention.

February 6, 1877.—Davy was the first to produce a light by means of electricity, and to him we owe the term 'arc' light. His experiments were made in 1808 with a battery of 2000 cells. Fifty years later practical experiments were made with the arc light fed from magneto-electric machines. With the invention of the dynamo—especially of that of Gramme—further developments took place. Among notable inventions was that of Paul Jablochkoff, who on Feb. 6, 1877, took out the British patent for the so-called 'Jablochkoff candles,' consisting of two parallel strips of carbon separated by kaolin. These lights were installed in the Place de l'Opéra, Paris, and on the Thames Embankment, and with them begins the history of street lighting by electricity.

February 7, 1817.—The great coal gas industry of to-day had its birth in England and France. Gas lighting in America owed much to the artist Rembrandt Peale, who founded Peale's Museum in Baltimore, where he exhibited his pictures and gave lectures. Through his efforts Baltimore was the first American city to adopt gas, the streets being lit for the first time on Feb. 7, 1817. Boston was lighted by gas in 1821 and New York in 1823, but there was considerable opposition to the innovation, and so important a city as Philadelphia had no public gas lighting until 1841.

February 8, 1841.—In 1802, Thomas Wedgwood produced evanescent outlines of shadows on paper moistened with a solution of silver nitrate, but the first photographs of practical value resulted from the work of Daguerre and Niepce. Daguerre's process was described by Arago in January 1839, and in the same month Fox Talbot described his own discovery of photogenic drawing. Two years later, on Feb. 8, 1841, Talbot patented his 'Calotype' or 'Talbotype,' which laid the foundation of modern photography and led to his being called the 'father of photography.'

February 9, 1832.—In the 'twenties and 'thirties of last century a number of steam road-carriages were built and plied for hire. One of the inventors was William Church, whose patent, taken out on Feb. 9, 1832, included a vertical boiler and wheels with elastic rims and spokes. The efforts of Church and his contemporaries Hancock, Gurney and others were, however, rendered futile by the Road Locomotive Act of 1836, which imposed so high a tax on such vehicles that they could not be made to pay.

February 10, 1906.—A modern battleship is an epitome of the application of scientific discovery and mechanical invention, there being few branches of science or engineering which are not utilised in her design, construction, equipment, or maintenance. No battleship ever created more interest than H.M.S. *Dreadnought*, which was launched on Feb. 10, 1906. Designed by Sir Philip Watts, the vessel was 490 feet long, 17,900 tons displacement, mounted ten 12-inch guns, and cost £1,783,883. It was also the first battleship in the world to be driven by Parsons steam turbines, the adoption of which saved 1000 tons in weight and £100,000 in cost.

February 11, 1853.—Through Bence Jones, who had heard of his work in Berlin, Tyndall on Feb. 11, 1853, delivered his first lecture at the Royal Institution, the subject being "On the Influence of Material Aggregation upon the Manifestations of Force." The lecture, which dealt mainly with magnetism, made Tyndall famous as a lecturer, and four months later he was elected professor of natural philosophy, an appointment he held with distinction for thirty-four years.

E. C. S.

Societies and Academies.

London.

Royal Society, Jan. 27.—**S. A. Asdell and F. H. A. Marshall**: The effect of the ovarian hormone in producing pro-œstrous development in the dog and rabbit. Injections of follicular extract obtained from solution in alcohol produce typical pro-œstrous changes in the uterus of the bitch and of the rabbit during the ancœstrous period (that is, at a time when the uterus is normally quiescent). There was also a growth of the vaginal epithelium, followed by a breaking down of the cornified cells. No definite œstrus was produced, so that in the actual production of œstrus a further factor may be involved.

S. Dickinson: Experiments on the physiology and genetics of the smut fungi: hyphal fusion. In investigating the cytology of the covered smuts of oats and barley in pure culture, the fusion, both within and across the species investigated, between the mycelia of different 'gender' derived from single sporidial isolations, was observed. The fusion-hypha is binucleate, and there is nothing suggesting nuclear fusion. The binucleate fusion-hypha gives rise to uninucleate hyphæ, which are of different gender, these being produced at different ends of the fusion-hypha.

J. W. H. Harrison: Experiments on the egg-laying instincts of the sawfly *Pontania salicis* Christ. and their bearing on the inheritance of acquired characters; with some remarks on a new principle in evolution. This gall-making sawfly possesses local races, each with its own special species of Salix as its food-plant. Direct experiment proved that the instinct to oviposit on such special species was inherited. By compelling a *Salix Andersoniana* race of *P. salicis* to lay its eggs on the hybrid willow *Salix purpurea* × *S. viminalis* over a period of years, the habit of choosing that hybrid as food-plant was developed and germinally fixed. This was proved by experimental attempts to throw it back once more on *Salix Andersoniana*. This is a case of the inheritance of acquired characters. Coupling these results with those on the induction of melanism in the Lepidoptera by chemical means, a new principle of evolution on the basis of direct chemical influences on the germ-plasm, whether in the form of the compulsory taking of new food-plants, changed soil conditions, or otherwise, is developed.

L. A. Harvey: The history of the cytoplasmic inclusions of the egg of *Ciona intestinalis* (L.) during oogenesis and fertilisation. Mitochondria are present as chromophobe vesicles with acidophil auræ in the youngest oocytes. They increase in number enormously, and practically all except those in the narrow peripheral layer swell to form yolk. After extrusion of test-cells the remaining mitochondria become granular and uniformly acidophil. The peripheral layer forms a deep cup, which becomes shallower and thicker at the time of fertilisation. The Golgi apparatus passes from primary diffuse to complex, and then to secondary diffuse stage. It consists always of small argentophil vesicles and irregular masses. It is suggested that the 'yolk nucleus' is secreted by the Golgi apparatus very early in oogenesis. It fragments and becomes dissolved in the cytoplasm. The test-cells pour lipoid materials into the egg during yolk formation. The cytoplasm passes from primary oxyphily to basophily and then to secondary oxyphily. These changes are correlated with changes in the Golgi apparatus, as described by Hirschler. The germinal vesicle bursts and the reconstituted nucleus reaches the metaphase of the first maturation division usually before the egg leaves the ovary.

E. Ponder: The measurement of percentage hæmolysis (ii). Two methods for investigating the percentage hæmolysis curves are described; the first, a modification of the radiometer method published in 1924, and the second, using the resistance of selenium as a measure of the light passing through the cell suspension. The form of the curves, for systems in which the lysin is acting alone, can be exactly explained by the assumption that a monomolecular reaction proceeds among a population the resistances of which are distributed according to a frequency curve, usually of Pearson's Type II. The lysins dealt with are saponin and sodium taurocholate. The effect of the accelerators and inhibitors is to alter the resistance of the population to the lysin, the alteration of resistance being described by an expression containing the single resistance constant *R*.

Physical Society, Dec. 10.—**Albert Campbell**: A capacitance bridge of wide range and a new inductometer. A bridge is described by which quick measurements can be made of capacitances covering a range of from 1 $\mu\mu$F up to 30 μF, the power factor also being indicated. The unknown capacitance *C* is put in parallel with a resistance *P*, and the effective self-inductance of the combination, which is approximately equal to $-P^2C$, is read on a mutual inductometer forming part of the bridge. By giving *P* a series of suitable values, scale multipliers prpviding for a very wide range of capacitance are obtained. The inductometer has a circular scale extending to about 260°, the percentage accuracy of reading being almost constant over the greater part of the range. A small rheostat allows the power loss in the condenser to be balanced, and enables the power factor to be deduced.—**Frank Wenner**: A principle governing the distribution of current in systems of linear conductors. The principle applies to systems of linear conductors in which the currents are proportional to the impressed electromotove forces; the electromotive forces may be any function of time, and may be distributed in any manner throughout the system; and the branches may contain resistance, inductance, capacitance or any two or all of these in series, may be so arranged as to move with respect to a permanent magnet, thus developing counter electromotive forces, and may be connected by contacts or mutual inductances or both of these. For such a system of conductors the current in any branch is that which would result if all impressed electromotive forces were replaced by a single impressed electromotive force, located in the particular branch and equal to the drop in potential which originally would have appeared across the break had this branch been opened. While this principle is a logical consequence of well-known laws, it has been very little used. It may be used to advantage in practically all cases in which the conductors form a series-parallel combination or a network which may be changed to a series-parallel combination by opening the branch in which it is desired to determine the current.

PARIS.

Academy of Sciences, Dec. 27.—**H. Deslandres**: The law of distribution of magnetic storms and of their elements. Consequences as regards the constitution of the sun. The notes on this subject published during 1926 are amplified and the general conclusions confirmed, mainly from an analysis of the magnetic observations made at Greenwich.—**L. de Launay**: Some geological applications of transmutation [of elements]. Examples are given of a certain number of constant ratios between two metals associated in the same deposit: silver and lead, gold and silver, platinum with rhodium, palladium and iridium, cadmium and zinc, cobalt and nickel.—**Paul Vuillemin**: New data on the supplementary folioles of strawberry plants.—**Paul Montel**: The series of meromorphic functions.—**R. Wavre**: Iteration by means of a symmetrical and singular nucleus of Fredholm.—**Kolmogoreff**: A divergent Fourier-Lebesque series.—**Swyngedauw**: The angular slip of pulleys and the slip of the driving and driven fibres of the strap.—**Maurice Girault**: A very general construction of the profiles of wings by conformal transformation of a circle.—**A. Couder, A. Danjon, and A. Dufay**: The astronomical quality of the sky of Haute-Provence. Details of studies in this region with the view of placing a large telescope there. The meterological data available suggest that this region should be a very favourable one for astronomical observations. This has been confirmed by direct telescopic work with four instruments.—**Th. Vautier**: Forms and deformations of explosive waves.—**C. Raveau**: The principle of Carnot and the principle of Clausius; various forms of enunciation.—**Georges Déjardin**: The spark spectrum of mercury in the extreme ultra-violet. Measurements of wave-lengths of the three spectra are given up to the limit of the Schumann region.—**Herbert Brennen**: The absorption of β-rays by matter.—**Léon W. Collet and Robert Perret**: Complements on the geology of the circus of Sales (Chaîne des Fis, Haute-Savoie).—**Louis Dangéard**: Current glaucon deposits in the neritic zone.—**Paul Bertrand**: The Mixoneura zone of the upper Westphalian.—**E. de Wildeman**: The yecco, a plant containing caffeine, originating in Colombia.—**A. Hée**: The variations of the respiratory intensity of *Sterigmatocystis nigra* in the course of development.—**G. Mouriquand and A. Leulier**: Does adrenaline exist in the completely free state in fresh suprarenal capsules? The experiments described appear to show that in the fresh suprarenal capsule (guinea-pig) the adrenaline behaves as though it were partly in combination.—**Paul Wintrebert**: Clearing up the eggs of the skate for the continuous observation of the development *in vivo*.—**Y. Manouelian and J. Viala**: Whence comes the virulence of the saliva in rabid animals?—**René Leriche and R. Fontaine**: Some new facts bearing on current theories of vasomotor action.—**A. Sartory, R. Sartory, and J. Meyer**: The formation of the perithecium in *Aspergillus fumigatus* under the influence of radium.—**Edm. Sergent, A. Donatien, L. Parrot, F. Lestoquard, and E. Plantureux**: The virulence of the blood in South African theilerosis (*Theileria parva*).

BRUSSELS.

Royal Belgian Academy, Jan. 9, 1926.—**George Homès**: Stable equilibrium in physico-chemical systems.—**Seligmann and Maury**: The geodesic work of the military cartographic institute.—**Delporte**: Minor planets discovered at the Royal Observatory of Belgium, at Uccle. Two new planets have been discovered since January 1924, when a Zeiss astrograph was installed. The elements of one of these (1925 VD) are given.

Feb. 6.—**A. Gravis**: Contribution to the anatomical study of the shortening of roots.—**A. Demoulin**: The method of the mobile bi-rectangular trihedron and some of its applications.—**Th. De Donder and G. Van Lerberghe**: The electromotive force of irreversible hydro-electric cells.—**R. Moens**: A new method of obtaining sustained electrical oscillations.—**G. Chavanne**: An inactive 1·3 dimethylcyclopentane.—**Maurice Robert**: The geology of the Katanga.—**Du Buisson**: Observations on the tracheal ventilation of insects.—**N. Saltykow**: The application of integrable elements to the integration of differential equations.

Mar. 6.—**Th. De Donder** and **G. Van Lerberghe**: The maximum yield of the chemical reactions of gaseous systems.—**J. Vincent**: The theory of cyclones and anticyclones. An adverse criticism of the theory of V. Bjerknes.—**Maurice Van Rysselberge**: The preparation and study of some 1·2 dimethylcyclopentane compounds.—**G. Balasse**: Study of the luminescence of potassium vapour in the electrodeless discharge.

ROME.

Royal Academy of the Lincei, Nov. 21.—**G. Scorza**: A lemma on the prolongation in the complex body of certain real algebraics.—**G. Armellini**: The variation of the eccentricity in the problem of two bodies of variable masses.—**Q. Majorana**: A residual thermal phenomenon. When heated to high temperatures and then allowed to cool to the ordinary temperature, lead, iron, and copper exhibit rises in temperature incompatible with the known laws of the progressive cooling of bodies.—**F. Zambonini** and **A. Stolfi**: Double sulphates of rare earth and alkali metals. Investigation of a portion of the system $La_2(SO_4)_3 : (NH_4)_2SO_4 : H_2O$ at 25° indicates the formation of the double compounds, 1 : 1 : 2, 1 : 3 : 0, 1 : 5 : 0, and 1 : 6 : 0.—**G. Krall**: The infinitesimal deformation of the field of integration in Fredholm's equations.—**E. Bompiani**: Point and contact transformations in a plane.—**B. Segre**: A generalisation of Koenigs' transformation.—**A. Masotti**: Uniform translation of a round cylinder in a channel with plane parallel sides; second approximation.—**G. de Mottoni**: Control experiments for a new interferometric method for the measurement of microscopic and ultra-microscopic objects by means of diffraction gratings. The percentage error of measurements made by the method recently described has the mean value 3·2 and the maximum value 5·0 per cent.—**E. Fermi** and **E. Persico**: The principle of adiabatics and the notion of kinetic energy in the new undulatory mechanics.—**D. Bigiavi**: Reactions of nitroxyl with aromatic nitro-derivatives and with azoxy-compounds. When an aromatic nitro-compound reacts with nitroxyl, obtained as the sodium derivative together with sodium nitrite when a solution of the sodium salt of nitrohydroxylamine is heated, the nitroxyl is oxidised to sodium nitrite by the nitro-compound, which is transformed into nitroso-compound; the latter does not separate, but immediately reacts with the nitroxyl to give the nitrosoarylhydroxylamine. Azoxy-compounds react similarly with nitroxyl, azoxybenzene, for example, yielding azobenzene and the sodium salt, $C_6H_5 \cdot N : N(C_6H_5) : NONa$.—**F. De Carli**: Additive compounds of sulphur dioxide and aromatic hydrocarbons. Investigation of the diagrams of crystallisation shows that sulphur dioxide forms with toluene the compounds $C_6H_5 \cdot CH_3, 2SO_2$ and $C_6H_5 \cdot CH_3, 3SO_2$, with mesitylene the compound $C_6H_3(CH_3)_3, SO_2$, and with pseudocumene the compound $C_6H_3(CH_3)_3, SO_2$.—**R. Fabiani**: Remains of an eruptive apparatus of Jurassic age found in Sicily.—**F. Rodolico**: Crystallographic investigations on certain hetero-poly-compounds.—**V. Ronchi**: The optical function of the lachrymal liquid.

SYDNEY.

Royal Society of New South Wales, Nov. 3.—The late **J. H. Maiden** and **W. F. Blakely**: Description of fifteen new acacias, and notes on several other species. Of the new species described, eleven are indigenous to New South Wales, two to Victoria, and two to South Australia; twelve belong to series Uninerves, and one each to series Plurinerves, Juliflorae (Stenophyllae) and Bipinnatae (Botryocephala).—**G. J. Burrows**: The solution volume of a solute in liquid mixtures. When a solute is dissolved in a mixture of water with an alcohol or acetone, the contraction that takes place is smaller than that resulting from the solution of the same solute in either of the separate liquids. This result would indicate that there is some relationship between the compressibility of a liquid and the apparent solution volume of a solute in that liquid. By considering the actual contractions that take place when a liquid solute is dissolved in these liquids, however, it is found that the relationship is not quantitative, and it is concluded that volume changes in these cases cannot be reconciled with any simple mechanical theory of closer packing.—**Miss E. M. Bartholomew** and **G. J. Burrows**: The preparation of certain iodo-bismuthites. In an unsuccessful attempt to prepare iodo-bismuthates, the corresponding bismuthites of certain bases such as aniline, dimethyl aniline, phenyldimethyl arsine, etc., were isolated. These are all crystalline compounds which can be recrystallised from concentrated hydrochloric acid without change. They may all be regarded as derivates of bismuthous iodide. The anilinium, pyridinium, dimethyl anilinium, and *p*-toluidinium salts are all derivatives of hexa-iodo bismuthous acid, $H_3(BiI_6)$, whilst phenyl dimethyl arsonium tetra-iodo bismuthite is a derivative of the acid $H(BiI_4)$.—**G. J. Burrows**: The salinity of the water of the Gulf of Carpentaria. Samples of water collected at various positions in the Gulf of Carpentaria have been analysed for the chlorine content. In all cases the salinity is lower than would be expected if the sea water were not diluted with fresh water. The low salt content can be attributed partly to the discharge of fresh water from rivers such as the Roper or Mitchell. The results, however, also show the effect of dilution of the sea water by water from the artesian basin.—**W. R. Browne**: The geology of the Gosforth district, N.S.W. Part 1, General geology. The strata belong mainly to the Kuttung or upper division of the Carboniferous system, but the basal stage of the division is not revealed. A maximum thickness of about 8000 feet of strata is exposed, consisting mostly of lavas ranging from pyroxene andesite to rhyolite, felsite-tuffs, aqueo-glacial conglomerates, varve-shales and tillite. On top of these, with disconformity or slight overlap, lie the Permo-Carboniferous Lower Marine beds. The main structural feature is an irregular dome, of late Permo-Carboniferous age, which has been heavily faulted. The physiography is bound up with the evolution of the Hunter River and the dissection of the faulted dome.

VIENNA.

Academy of Sciences, Dec. 2.—**A. Smekal**: The optical proof of lacunae in the molecular structure of actual crystals. There are deviations from the ideal lattice structure or pores in the lattice. The evidence is in the internal sensitiveness for wave-lengths which are greater than the resonance wave-lengths of the lattice. Alkali salts can be coloured by radiation with ultra-violet light.—**H. P. Cornelius** and **M. Furlani-Cornelius**: Geological researches in the upper Val Camonica.—**H. P. Cornelius**: Geological researches in the lower Veltlin and at the northern end of Lake Como.—**E. Bersa**: Radio-biological investigations; the question of Rontgen radiation of seedlings. Sinapis, Vicia, and Zea were used. A transitory depression was noted in the rate of growth of roots with later recovery.—**S. Strugger**: The influence of hydrogen ion concentration on the protoplasm of root-hairs in *Hordeum vulgare*. The velocity of the plasma streaming was studied between *p*H 6·80 and *p*H 5·50.—**F. Hölzl**: Organic acids and bases in non-aqueous solution. Combinations of amines with dicarbon and aromatic acids were submitted to conductivity measurements.

Official Publications Received.

BRITISH AND COLONIAL.

Board of Education. Report of the Consultative Committee on the Education of the Adolescent. Pp. xxiv+339. (London: H.M. Stationery Office.) Paper, 2s. net; cloth, 3s. net.

Air Ministry: Meteorological Office, London. Southport Auxiliary Observatory (The Fernley Observatory of the Corporation of Southport). Annual Report, and Results of Meteorological Observations, for the Year 1925. By Joseph Baxendell. Pp. 28. (Southport: Fernley Observatory; London: Meteorological Office.)

Board of Trade. Catalogue of the British Industries Fair, 1927, The White City, Shepherd's Bush, London, W.12, February 21st–March 4th, Organised by the Department of Overseas Trade. Special Overseas Advance edition. Pp. xxxii+804+Ad. 160. (London: Department of Overseas Trade.)

Ministry of Agriculture and Fisheries. Miscellaneous Publications, No. 56: Clean Milk Competitions in 1924–1925. Pp. 16+1 plate. (London: Ministry of Agriculture and Fisheries.) 4d. net.

Aberdeen Public Library. Forty-second Annual Report of the Committee for the Year 1925–1926. Pp. 43. (Aberdeen.)

Journal of the Society for the Preservation of the Fauna of the Empire. *New Series, Part 6, December. Pp. 98. (London: H. F. and G. Witherby.)*

Proceedings of the Society for Psychical Research. Part 101, Vol. 36, January. Pp. 396–435. (London: Francis Edwards.) 2s.

The Physical Society. Proceedings, Vol. 39, Part 1, December 15. Pp. 97. (London: Fleetway Press, Ltd.) 6s. net.

The Observer's Handbook for 1927. Edited by C. A. Chant. Nineteenth Year of Publication. Pp. 72. (Toronto: Royal Astronomical Society of Canada.)

Department of Scientific and Industrial Research. Report of the Fuel Research Board for the Year 1925; with Report of the Director of Fuel Research. Pp. vi+79. (London: H.M. Stationery Office.) 1s. 3d. net.

Report on the Zoological Survey of India for the Years 1923 to 1926. Pp. liii+3 plates. (Calcutta: Government of India Central Publication Branch.) 1.7 rupees; 2s. 6d.

South Australia: Department of Mines. Mining Review for the Half-year ended June 30th, 1926. (No. 44.) Pp. 63+5 plates. (Adelaide: R. E. E. Rogers.)

Bird Sanctuaries in Royal Parks in Scotland: Report of the Committee appointed by Viscount Peel to consider the Establishment of Bird Sanctuaries in the Royal Parks in Scotland. Pp. 10. (London: H.M. Stationery Office.) 6d. net.

The West of Scotland Agricultural College, Glasgow. Calendar for Session 1926–1927. Pp. xv+166. 1s. Annual Report and Appendices, 1925–1926. Pp. 121. (Glasgow.)

The Journal of the Institution of Electrical Engineers. Vol. 65, No. 361, January. Pp. 97-184+xxviii. (London: E. and F. N. Spon, Ltd.) 10s. 6d.

Australasian Antarctic Expedition, 1911–14. Scientific Reports, Series C: Zoology and Botany. Vol. 8, Part 3: Echinodermata Echinoidea. By Prof. René Koehler. Pp. 134+plates 91-124. (Sydney, N.S.W.: Alfred James Kent.) 33s.

Government of the Gold Coast. Report on the Survey Department for the Period April 1925–March 1926. Pp. 27+5 plates. (Accra: Colonial Secretariat; London: The Crown Agents for the Colonies.) 2s.

Proceedings of the Royal Irish Academy. Vol. 37, Section A, No. 7: Atmospheric Ionisation. By Prof. J. J. Nolan and G. P. de Sachy. Pp. 71-94. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 1s.

Professional Schools Post-Graduation Courses: Specialist Studies in the Universities and University Colleges of Great Britain and Ireland, Session 1926–7. Pp. 32. (London: Universities Bureau of the British Empire.)

Students from other Countries in the Universities and University Colleges of Great Britain and Ireland in October 1926. Pp. 31. (London: Universities Bureau of the British Empire.) 1s.

The North of Scotland College of Agriculture. Report on the Work of the North of Scotland College for the Year 1925–26. Pp. 31. (Aberdeen.)

Proceedings of the Royal Society of Victoria. Vol. 39 (New Series), Part 1, November 11th. Pp. iv+52+6 plates. (Melbourne.)

FOREIGN.

Ministère de l'Instruction Publique et des Beaux-Arts. Enquêtes et documents relatifs à l'enseignement supérieur. 121: Rapports sur les observatoires astronomiques de Province. Année 1925. Pp. 89. (Paris: Imprimerie Nationale.)

The Danish Ingolf-Expedition. Vol. 5. 10: Medusæ. Part 2: Anthomedusæ. By P. L. Kramp. Pp. 105+2 plates+1 map. (Copenhagen: Bianco Luno.)

International Geodetic and Geophysical Union (Union Géodésique et Géophysique Internationale): Section of Terrestrial Magnetism and Electricity. Bulletin No. 6: Preliminary Reports on Subjects of Investigation. Pp. 40. (Baltimore, Md.: Johns Hopkins Press.) 50 cents.

United States Department of Agriculture. Department Bulletin No. 1426: The Clover Root Borer. By L. P. Rockwood. Pp. 48. (Washington, D.C.: Government Printing Office.) 10 cents.

Proceedings of the American Philosophical Society held at Philadelphia for Promoting Useful Knowledge. Vol. 65, No. 3. Pp. 141-248. (Philadelphia, Pa.)

Ministry of Agriculture, Egypt: Technical and Scientific Service Bulletin No. 72: Contribution to the Knowledge of the Coccidæ of Egypt. By W. J. Hall. Pp. iii+41+13 plates. (Cairo: Government Publications Office.) 10 P.T.

Calendario del Santuario e delle opere di beneficenza cristiana di Valle di Pompei, 1927. Pp. 256. (Valle di Pompei.)

Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. 78. Gabb's California Fossil Type Gastropoda. By Ralph B. Stewart. Pp. 287-447+plates 20-32. (Philadelphia, Pa.)

Proceedings of the United States National Museum. Vol. 69, Art. 6: A new Sea Star of the Genus Evasterias. By W. K. Fisher. (No. 2632.) Pp. 5+2 plates. Vol. 69, Art. 20: Additional new Mollusks from Santa Elena Bay, Ecuador. By Paul Bartsch. (No. 2646.) Pp. 20+3 plates. Vol. 70, Art. 1: American Wasps of the Genus Sceliphron Klug. By Bennet A. Porter. (No. 2650.) Pp. 22+4 plates. Vol. 70, Art. 4: New Urocoptid Land Shells from Mexico. By Paul Bartsch. (No. 2653.) Pp. 13+1 plate. Vol. 70, Art. 10: *On a Collection of Copepods from Florida, with a Description of Diaptomus Floridanus, New Species.* By C. Dwight Marsh. (No. 2659.) Pp. 4. (Washington, D.C.: Government Printing Office.)

Fish and Game Commission of California. Fish Bulletin No. 11: The California Sardine. By the Staff of the California State Fisheries Laboratory. (Contributions Nos. 52-56 from the California State Fisheries Laboratory.) Pp. 221. (Terminal, Calif.: State Fisheries Laboratory.)

Annuaire astronomique et météorologique Camille Flammarion pour 1927: exposant l'ensemble de tous les phénomènes célestes observables pendant l'année, avec revue astronomique et météorologique, notices scientifiques, tableaux et documents. 63e année. Pp. 130. (Paris: Ernest Flammarion.) 12 francs.

Denkschriften der Schweizerischen Naturforschenden Gesellschaft, Band 63: Mémoires de la Société Helvétique des Sciences naturelles, Vol. 63. Pp. iv+340. (Zurich.)

Department of Commerce: Bureau of Standards. Technologic Papers of the Bureau of Standards, No. 328: Tests of Large Columns with H-shaped Sections. By L. B. Tuckerman and A. H. Stang. Pp. 33+6 plates. 40 cents. Technologic Papers of the Bureau of Standards, No. 333: Transmission of Sound through Voice Tubes. By E. A. Eckhardt, V. L. Chrisler, P. P. Quayle and M. J. Evans; with a Note on the Absorption of Sound in Rigid Pipes, by Edgar Buckingham. Pp. 163-193+1 plate. 15 cents. (Washington, D.C.: Government Printing Office.)

United States Department of Agriculture. Department Bulletin No. 1423: *Progress of Reindeer Grazing Investigations in Alaska.* By Lawrence J. Palmer. Pp. 37+18 plates. 15 cents. Farmers' Bulletin No. 1503: The Horse Bots and their Control. By F. C. Bishopp and W. E. Dove. Pp. ii+14. 5 cents. (Washington, D.C.: Government Printing Office.)

CATALOGUES.

The 'Scholes' Bomb for Solid and Liquid Fuel Calorimetry. Pp. 16. (Manchester and London: G. Cussons, Ltd.)

A Catalogue of Books published by the Syndics of the Cambridge University Press. Pp. xv+272. (London: Cambridge University Press.)

Diary of Societies.

SATURDAY, FEBRUARY 5.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 10.30 A.M.—Dr. C. P. Symonds: Cerebral Abscess; Some Points in Diagnosis and Localisation.—Dr. Farquhar Buzzard: The Treatment of Traumatic Facial Paralysis.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—W. de la Mare: Craftsmanship in Verse.

INSTITUTION OF AUTOMOBILE ENGINEERS (Western Centre) (at Law Courts, Cardiff), at 6.30.—J. Younger: Maintenance in the United States.

MONDAY, FEBRUARY 7.

BIOCHEMICAL SOCIETY (at Lister Institute), at 3.30.—Exhibits and Demonstrations:—W. T. J. Morgan: Apparatus for Pregl's Methods of Micro-analysis.—T. Lumsden and A. C. Kohn-Speyer: Simplified Method of Tissue Culture.—F. M. Burnet: Bacteriophage Phenomena.—M. Rhodes: National Collection of Type Cultures. Strains employed in Industry.—N. S. Lucas: Apparatus for determining the Coefficient of Absorption of Ultra-violet Rays for Skin.—At 5.—Papers:—C. Dorée and E. C. Barton-Wright: A New Type of Alkali Lignin.—F. Dickens, E. C. Dodds, W. Lawson, and N. F. Maclagan: Observations on the Purification and Properties of Insulin.—P. Eggleton and M. G. Eggleton: The Significance of Phosphoric Acid in Muscular Contraction.—I. S. MacLean and C. G. Daubney: The Lipins of Yeast.—W. T. J. Morgan: Methylated Derivatives of Hexosephosphoric Acids.—Prof. A. Harden: Meyerhof's Theory of Alcoholic Fermentation.—Prof. L. F. Hewitt: Proteins of the Cerebro-spinal Fluid.—M. H. Roscoe: Nitrogen Metabolism Technique for Use with Small Animals.—H. W. Southgate: An Efficient Gas Scrubber.—O. Rosenheim and T. A. Webster: On the Nature of Provitamin D.—J. R. Marrack: The Effect of the Reaction on the Osmotic Pressure of Serum Proteins.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Rev. Dr. G. A. F. Knight: *The Identification of the Pharaohs of the Pentateuch.*

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

SOCIETY OF ENGINEERS (at Geological Society), at 5.30.—D. C. Fidler: Presidential Address.

INSTITUTION OF AUTOMOBILE ENGINEERS (Bristol Centre) (at Merchant Venturers' Technical College, Bristol), at 6.45.—A. H. R. Fedden: The Supercharging of Aircraft and Motor Vehicle Engines.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—R. Grierson and others: Discussion on Some Interesting Features in Modern Installation Work.

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.—Dr. T. Slater Price: Photographic Sensitivity.

INSTITUTION OF THE RUBBER INDUSTRY (London and District Section) (at Engineers' Club, Coventry Street), at 8.—H. Turner: Set in Vulcanised Rubber.—H. Standring: Rubber Toys.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—J. H. Driberg: The Didinga Mountains.

MEDICAL SOCIETY OF LONDON, at 8.30.—Dr. F. Walshe, Dr. M. Gordon, and Sir Thomas Horder: Discussion on Poliomyelitis.

TUESDAY, February 8.

Royal Institution of Great Britain, at 5.15.—Prof. J. S. Huxley: Problems of Animal Growth and Development (2).

Institution of Petroleum Technologists (at Royal Society of Arts), at 5.30.

Zoological Society of London, at 5.30.—The Secretary: Report on the Additions to the Society's Menagerie during the months of November and December 1926 and January 1927.—W. E. Le Gros Clark: Exhibition of Photographs of a Living Tree-Shrew (*Tupaia minor*).—Major S. S. Flower: Loss of Memory accompanying Metamorphosis in Amphibians.—Dr. H. H. Woollard: The Differentiation of the Retina in the Primates.—Dr. F. P. Stowell: Physical and Chemical Conditions in the Fresh-water Circulation of the Society's Aquarium.—Oldfield Thomas: The Delacour Exploration of French Indo-China—Mammals.—Edith M. Sheppard: Revision of the Family Phreatoicidae (Crustacea) with a Description of Two New Species.—Chi Ping: On the Structures of the Hard Palate of *Felis tigris*.—R. Gurney: Some Australian Fresh-water Entomostraca reared from Dried Mud.

Institute of Marine Engineers, at 6.30.—J. G. Weir: Feed Water Circuits for Marine Installations.

Institution of Electrical Engineers (East Midland Sub-Centre) (at College, Loughborough), at 6.45.—H. V. Field: Applications of the Oscillograph.

Electrical Association for Women (jointly with Association of Teachers in Domestic Subjects) (at E.L.M.A. Lighting Service Bureau, Strand), at 7.—W. H. Bush: Electric Light in the Home and in the School.

Institution of Electrical Engineers (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—Informal Discussion on Electric Heating and Cooking.

Institution of Electrical Engineers (North-Western Centre) (at Engineers' Club, Manchester), at 7.—A. R. Cooper: Electrical Equipment of Track on the Underground Railways of London.

Royal Photographic Society of Great Britain (Kinematograph Group), at 7.

Society of Chemical Industry (Birmingham and Midland Section) (at Birmingham University), at 7.15.—F. Twyman: Metallurgical Spectroscopic Analysis.

Institution of Automobile Engineers (Coventry Centre) (at Broadgate Café, Coventry), at 7.30.—A. H. R. Fedden: The Supercharging of Aircraft and Motor Vehicle Engines.

Society of Chemical Industry (South Wales Section) (at Technical College, Cardiff), at 7.30.—Prof. J. Mangan: Micro-organisms of the Soil.

Institution of Electrical Engineers (Scottish Centre) (at McLellan Galleries, Glasgow), at 7.30.—Prof. W. M. Thornton: What is Electricity? (Faraday Lecture).

North-East Coast Institution of Engineers and Shipbuilders (Middlesbrough Branch) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.—O. Hurst: Some Notes on Naval Architecture.

Quekett Microscopical Club, at 7.30.—Annual General Meeting.

Pharmaceutical Society, at 8.—W. Wyatt: The Acts of Parliament relating to Stamped Medicine.

Royal Anthropological Institute, at 8.30.—Prof. W. J. Sollas: The Chancelade Skull.

WEDNESDAY, February 9.

Institution of Heating and Ventilating Engineers (at Holborn Restaurant), at 2.30.—J. L. Musgrave: Presidential Address.—Dr. Margaret Fishenden: The Effect of Weather Conditions upon the Heat Requirements of a House.

Royal Society of Medicine (Surgery: Sub-Section of Proctology), at 5.—Dr. H. Spriggs (Medical), Sir Charles Gordon-Watson (Surgical), Dr. B. Shires (Radiological), and others: Discussion on Diverticulitis.

Institution of Electrical Engineers (South Midland Centre) (at Midland Institute, Birmingham), at 7.—Prof. W. M. Thornton: What is Electricity? (Faraday Lecture).

Institution of Welding Engineers (at Milton Hall, Deansgate, Manchester), at 7.—P. L. Roberts: The Welding of Cast Iron.

Royal Society of Arts, at 8.—Dr. E. F. Armstrong: The Romance of the Organic Chemical Industry.

THURSDAY, February 10.

Royal Society, at 4.30.—C. D. Ellis and W. A. Wooster: (*a*) The Photographic Action of β-Rays; (*b*) The Relative Intensities of the Groups in the Magnetic β-Ray Spectra of Radium B and Radium C.—A. Muller: An X-Ray Investigation of Certain Long-Chain Compounds.—*The following and other papers will be read in title only*:—Dr. G. M. B. Dobson and D. N. Harrison: Measurements of Ozone in the Earth's Atmosphere and its Relation to other Geophysical Conditions.—Part II.—L. H. Thomas: On the Capture of Electrons by swiftly moving Electrified Particles.

London Mathematical Society (at Royal Astronomical Society), at 5.—Prof. S. Chapman: Some Problems of Terrestrial Magnetism (Lecture).—*The following papers will be communicated by title only*:—T. W. Chaundy: The Genus of an Algebraic Twisted Curve.—E. Cooper: The Behaviour of Certain Series Associated with Limiting Cases of Elliptic Functions.—P. J. Daniell: A Note on Schrödinger's Wave Mechanics.—Prof. G. H. Hardy, A. E. Ingham, and G. Pólya: Notes on Moduli and Mean Values.—Prof. G. H. Hardy and J. E. Littlewood: Some Problems of 'Partitio Numerorum': VIII. The Number Γ(*k*) in Waring's Problem.—L. J. Mordell: A Tauberian Convergence Condition.

Royal Institution of Great Britain, at 5.15.—Sir William Bragg: Acoustical Problems treated by Lord Rayleigh (2): Echoes.

South London Entomological and Natural History Society, at 7.

Institution of Electrical Engineers (Dundee Sub-Centre) (at University College, Dundee), at 7.30.—D. Solar: Three-Phase Power Measurement.

Institute of Metals (London Local Section) (jointly with Electroplaters' and Depositors' Technical Society) (at 83 Pall Mall), at 7.30.—W. R. Barclay: Nickel Coatings—Methods of Production.

Optical Society (at Imperial College of Science), at 7.30.—T. Smith: Some Uncultivated Optical Fields (Presidential Address).

Chemical Society (at Institution of Mechanical Engineers), at 8.—Prof. E. Cohen: Kamerlingh Onnes Memorial Lecture.

Institution of Mechanical Engineers (Leeds Branch).—Prof. A. L. Mellanby and Prof. W. Kerr: Use and Economy of High Pressures in Steam Plant.

Institution of the Rubber Industry (Manchester Section).—J. Lloyd: Proofing.

FRIDAY, February 11.

Royal Society of Arts (Indian Meeting), at 4.30.—Sir E. Denison Ross: The Arabic History of Gujarat (Sir George Birdwood Memorial Lecture).

Royal Astronomical Society (Annual General Meeting), at 5.—Dr. J. H. Jeans: Address on the Award of the Gold Medal to Prof. Frank Schlesinger.

Malacological Society of London (at Linnean Society), at 6.

North-East Coast Institution of Engineers and Shipbuilders (at Literary and Philosophical Society, Newcastle-upon-Tyne), at 6.—Prof. F. Smith: Psychology as an Aid to Efficiency and Economy in Industry.

Institute of Metals (Swansea Local Section) (at University College, Swansea), at 7.15.—J. S. Caswell: The Design of Annealing Furnaces.

Junior Institution of Engineers, at 7.30.—Prof. K. Neville Moss: The Physiology of Work under High Air Temperature Conditions.

Institute of Metals (Sheffield Local Section) (at Sheffield University), at 7.30.—R. T. Rolfe: Bronze.

Oxford University Junior Scientific Club, at 8.15.—Speaker: F. Mitchell Hedges: Primitive Tribes and Buried Cities in Central America.

Royal Institution of Great Britain, at 9.—Dr. E. Law: Old Hampton Court Palace Revealed.

Institution of Mechanical Engineers (Liverpool Branch, jointly with Liverpool Engineering Society).—Prof. A. L. Mellanby and Prof. W. Kerr: Use and Economy of High Pressures in Steam Plant.

SATURDAY, February 12.

Royal Institution of Great Britain, at 3.—W. de la Mare: 'Atmosphere' in Fiction.

Mining Institute of Scotland (at Edinburgh).

PUBLIC LECTURES.

SATURDAY, February 5.

Horniman Museum (Forest Hill), at 3.30.—V. Gordon Childe: The Aryans, our Linguistic Ancestors.

SUNDAY, February 6.

Guildhouse (Eccleston Square), at 3.30.—Maulvi A. R. Dard: The Soul of Islam.

MONDAY, February 7.

University College, at 5.—Dr. A. S. Parkes: Reproduction. (Succeeding Lectures on February 14, 21, 28, March 7 and 14.)

King's College for Women (Household and Social Science Department), at 5.15.—F. Birrell: The Influence of Women on the Public Taste.

University of Leeds, at 7.—Prof. C. T. R. Wilson: Thunderclouds.

TUESDAY, February 8.

Bedford College for Women, at 5.15.—Prof. E. G. Gardner: Conceptions of the Cosmos according to Dante.

King's College, at 5.30.—C. E. M. Joad: Some Aspects of Vitalism: Vitalism and Emergence.

University College, at 5.30.—Dr. M. Wheeler: The Archæology of Great Britain, its Present and its Future. (Succeeding Lectures on February 15, 22, and March 1.)—At 6.15.—Miss E. Jeffries Davis: Some London Place Names. (Succeeding Lectures on February 15, 22, March 1 and 8.) (This course is a repetition of the one given in November 1926.)

WEDNESDAY, February 9.

University College, at 5.—Dr. E. D. Adrian: The Action of the Sense Organs. (Succeeding Lectures on February 16 and 23.)

THURSDAY, February 10.

King's College, at 5.30.—Prof. F. A. Lindemann: The Mind: Physics.

University College, at 5.30.—Dr. C. Sisson: Americans and American Universities.

Northampton Polytechnic Institute, at 7.—R. Genders: Steel and its Thermal Treatment: Defects in Steel.

Fulham Central Public Library, at 8.—R. Kearton: Wild Nature's Ways.

FRIDAY, February 11.

College of Medicine (Newcastle-upon-Tyne), at 4.45.—Dr. C. Singer: History of Medicine (2).

SATURDAY, February 12.

Horniman Museum (Forest Hill), at 3.30.—Miss M. Edith Durham: Some Old Montenegrin Customs.

SUNDAY, February 13.

Guildhouse (Eccleston Square), at 3.30.—N. C. Sen: Brahmo Somaj.

CONFERENCE.

February 10 to 12.

Conference on Maternity and Child Welfare (under auspices of the Society of Medical Officers of Health) (at Newcastle-upon-Tyne).—Papers on Infant Feeding, the Development of Maternity and Child Welfare Work, and the Prevention of Still-birth.

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How Should an Engineer be Trained?

A VERY interesting discussion followed the paper on the training of engineers given by Sir Theodore Morison on Oct. 29 before the North-East Coast Institution of Engineers and Shipbuilders; and a report of it has now been published by the Institution. Those engaging in the discussion were representative of every branch of the profession, and while on some questions differences of opinion were manifest, there was a number of interesting points on which opinion appeared to be practically unanimous. Among these was the general agreement that all university students of engineering should have at least one year's works experience before beginning their university training, and that during this period evening classes should be taken in mathematics and physics with the view of conserving the habit of study engendered at school.

This plan has been advocated for many years by a number of those engaged in university teaching, and it is of interest to know that such procedure now appears to be so generally approved among practising engineers who have studied the question of engineering training. Its advantages are many. It brings a student to his university course with a realisation of the bearing of its scientific training on his future career, such as, in the majority of cases, increases notably his keenness in the work. It gives him, at the most plastic stage of his life, intimate contact with the working man whom in future years he will probably have to control, while the routine work and drudgery which is usually connected with this first period of training is likely to weed out any one whose real interests are not in engineering, and to give him the opportunity of withdrawing before much time has been wasted.

The discussion would have been important if this were the only point on which it has given a definite lead. The chief difficulty in applying it is that at present scarcely any engineering firm in Great Britain is prepared to take a youth for one year preliminary to his university training. If the North-East Coast Institution can persuade its members to adopt this course, arranging to take the youth back to complete his practical training after his graduation, it will have done a very important piece of work and made a real advance in the training of engineers.

Another point emphasised in the discussion was the somewhat haphazard method adopted by the majority of firms in the shop training of their special apprentices. In this connexion matters have improved during the past fifteen years or so, but even now the number of firms which has arranged for the apprentices carefully graded courses of shop training, and see that this training is adhered to, is almost negligibly small.

The sandwich system, in which a youth spends alternate periods of six months in works and at the university, received some support. It is, however, becoming more generally acknowledged that the value to a young engineer of a university course lies almost as much in the facilities which are afforded him for intercourse with fellow students in his own and especially in other branches of study, and in the general activities of student life, as in the technical training which he receives; and that the necessity for keeping terms different from those of the remainder of the university, which is necessary where the sandwich system is adopted, is, from this point of view, a serious objection to the system.

Another point on which opinion was almost unanimous has reference to the requirements for entry to a university course. It was generally felt that the present matriculation regulations operate adversely in the case of many excellent students whose education prior to a shop apprenticeship has been obtained at an elementary school, and whose later work at evening technical schools has shown them to be excellent engineering material.

While one or two universities have recognised the difficulty and have made special provision for such students, the majority of British universities still insist on the normal matriculation, except indeed for mature candidates, and there is little doubt that this insistence is barring each year from the universities a number of young engineers who would richly repay their training.

As Sir Theodore Morison pointed out, engineering is becoming more and more dependent yearly on scientific developments, and its future in Great Britain will depend largely on the type of mind that can be recruited into the profession, and on the methods adopted in the training of engineers. These methods will be investigated by a committee of the North-East Coast Institution of Engineers and Shipbuilders, as suggested by Sir Theodore. It is now more than fifteen years since engineering education was discussed fully at a conference arranged by the Institution of Civil Engineers, and changing conditions have made desirable the re-examination of its many aspects. The recommendations of the committee set up by the North-East Coast Institution will be awaited, therefore, with much interest.

Archæology in South Africa.

The Stone Age in Rhodesia. By Neville Jones. Pp. xiv + 120 + 22 plates. (London: Oxford University Press, 1926.) 12*s*. 6*d*. net.

MR. NEVILLE JONES has earned our thanks for having brought together the evidence of various stone age cultures as derived from Rhodesia, together with some of the data culled from a wider South African area. He has produced a very readable book which contains some valuable information. The whole problem of the South African stone age cultures is every day becoming more interesting and suggestive; and now that search for relics is being conducted upon more scientific lines, we can see the opening of an archæological chapter of high importance. The author's own researches at Sawmills (South Rhodesia) and at Tiger Kloof and Taungs (Cape Province) are valuable as evidencing culture-levels of lower- and mid-Palæolithic *facies*, which can be clearly distinguished and placed in sequence order. He very rightly urges the paramount necessity of attacking the archæological problems from the viewpoint of geological evidence. The numberless stone implements which may be picked up on the surface can teach us little unless we can identify the geologica horizons to which they originally belonged. The spade alone can provide a clear idea as to the severa cultures which may be distinguished, and thei relative positions in the time-sequence. Mr Jones has worked conscientiously and thoughtfully, and his results help to advance the subject.

The value of the book is somewhat marred by unduly positive statements, which lack the support of evidence. To quote examples, which I hope may be modified in a future edition: On p. 1 (and cf. p. 19), in referring to mid-Palæolithic times, Mr. Jones says, "the core implement was thus gradually superseded by the flake implement and finally disappeared altogether." In actual fact core implements persisted in great abundance al through the Neolithic period, while within the Palæolithic period they form one of the most striking features of the Solutréan culture-phase On p. 23 he says, "In Europe the stone implement, in Palæolithic times at any rate, was invariably made of flint," a statement which is quite untrue, since chert, quartzite, and other materials were frequently employed. On p. 19, in his diagram (adapted from Osborn), he asserts that the "bone industry begins" in Solutréan times Why does he ignore the bone implements so char acteristic of the Aurignacian culture ? On p. 44 he states that "in the Maramba . . . the only large palæoliths found in its bed are of diorite." This is not my own experience, for I have picked up in the bed of this tributary of the Zambezi typical large palæoliths of chalcedony and other materials, in addition to those of diorite. It is rather unduly committal at the present stage of our knowledge to assert (p. 21) that "we know for a fact that South Africa was Aurignacian in culture until the Bantu immigrants introduced the use of iron." So positive a dogma is rather premature and may tend to hamper unbiassed research in a field which is essentially complex.

I find it sometimes difficult to follow the author in his descriptions of stone-working technique and in some of his diagnoses of implement types. The 'tortoise-core' figured on p. 53 appears to be quite aberrant and to lack the main characteristics of this specialised core-type. Mr. Jones remarks (p. 26) that "the Mousterian culture has not yet been demonstrated in Rhodesia," but if the 'tortoise-core' industry is mainly suggestive of that culture, as many maintain, it may interest him to know that I have found on the Zambezi banks excellent examples of the 'Levallois' flakes struck from such prepared cores.

The author's description of the probable process whereby the leaf-shaped blades from the Cape Flats were made can scarcely carry conviction. Has he ever tried to effect the "removal, probably *by pressure* [italics mine], of minute chips over the entire surface" of a large piece of quartzite ? If so, has he ever produced an effect similar to the surface-flaking of this type of implement ? I venture to doubt it. He compares (pp. 56 and 113) the finest of the Cape Flats implements with the best examples of Solutréan technique; but this seems to do scant justice to the marvellous skill exhibited by Solutréan man. Surely no blades in any way comparable with those of Volgu have as yet been found in South Africa, and the Cape Flats examples, for all their high quality, exhibit, to my mind, a far easier technique.

Mr. Jones (p. 12) defines a 'burin' as a 'boring instrument,' but its proper function was engraving, not drilling, and its archæological interest lies in its association with engraved designs. He has adopted the unsatisfactory term '*boucher*' for the '*coup-de-poing*' or 'hand-axe' series of lower palæoliths, and urges that this name "has the special virtue of being non-committal." But surely, quite apart from introducing a scheme of nomenclature by Christian names, which may easily lead to ridicule, the fact of its being non-committal is against its employment. Personally, I have been much exercised to discover exactly what type or types of implements it is intended to include under the term. Prof. Sollas originally applied it to a type of *flake* implement, but the present author and others employ it to designate *core* implements. It would be better to drop the term altogether and adopt a series of more committal and distinctive type-names.

The author does not refer to the discovery in Rhodesia of minute implements of Tardenoisian type, though it is many years since the first example was found in Buluwayo. Tardenoisian types are now being discovered abundantly in South Africa, and are a noteworthy feature of the region.

The illustrations of implements in this book vary much in value. Some (*e.g.* Fig. 39) are quite good; others are so lacking in detail and 'crispness' that they convey little beyond mere outline and nothing as regards technique. The description (p. 54) and the figure referred to (Fig. 13, No. 26) appear to be totally unrelated.

Apart, however, from these and several other points which invite criticism, the book is a welcome one, dealing with problems of ever-increasing interest. The author endeavours to approach his subject without bias, and to treat the evidence as he finds it. The task of correlating the South African stone age cultures with those of Europe is beset with pitfalls, but is none the less attractive on that account.

The author's diagnosis of Bushman art is carefully thought out and is in agreement with the most widely held views. His statement of the case for magic versus 'art for art's sake,' as the primary incentive, would have been greatly reinforced had he brought to bear upon it the evidence afforded by late Palæolithic art in Europe. It is interesting to note that he adopts the theory that the gravels lying along the top of the gorge of the Zambezi, below the Victoria Falls, are the remains of ancient gravels deposited by the Zambezi itself. My own investigations, conducted during three visits to the region (in 1905, 1907, and 1910), led me to adopt this view, which, *pace* Dr. Codrington, has been supported by several very able geologists. The Appendix III. in Mr. Jones's book, detailing the views of Dr. Hrdlička upon this problem, should not be taken too seriously. The very hurried survey conducted by a distinguished physical anthropologist, in company with two American newspaper men and a South African engineer, does not carry conviction, nor does it dispose of the views of such capable geologists as Lamplugh, Zealley, and others. Further, close examination by trained geologists is needed to settle the matter finally. The age of these Zambezi gravels is one of the most important problems awaiting solution.

HENRY BALFOUR.

Chemist and Philosopher.

The Anatomy of Science. By Prof. Gilbert N. Lewis. (Yale University: Mrs. Hepsa Ely Silliman Memorial Lectures.) Pp. x+221. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1926.) 14s. net.

"AS the artist, after painstaking effort, steps back from his easel to view his picture as a whole, so it may not be unprofitable for the scientist to forsake from time to time his own specialty and survey the general trend of science." So writes the author of this volume of Silliman lectures. Not only is such action not unprofitable, but also it is of the highest importance that leading men of science who, like Prof. G. N. Lewis, possess in such high degree wide scientific knowledge, clear philosophic insight, and the power of lucid and interesting expression, should from time to time examine the existing state of science and the directions along which our knowledge of the universe is advancing. The author's purpose in this volume is to present "a kind of contemporaneous cross section showing the inner structure of science," and the book is addressed to those "who are interested not so much in the products of science as in its methods." By all such, these lectures will be given a hearty welcome.

After a short survey of the methods of science, in which perhaps the rather too facile view is expressed that the scientific method is "hardly more than the native method of solving problems," the author proceeds to a discussion of the theory of numbers, space and geometry, time and motion, matter in motion, light and the quantum, probability and entropy, the non-mathematical sciences, and life, body and mind.

In the lecture on space and geometry are discussed the non-Euclidean geometries, more especially Minkowski's geometry of asymptotic rotation, the details of which have been worked out by the author and Prof. E. B. Wilson, and the geometry of shear rotation. According to Minkowski's geometry, all points on the hyperbolic curve are equidistant from the point of intersection of the asymptotes, and any interval marked off on one of these asymptotes is of zero length. To a Euclidean mind such language is nonsense, but, as the author points out, each geometry has its own definitions and postulates just as each game has its own rules; and to the query whether such geometry is true or false, the author replies that the question has no meaning in science. All that one is concerned with, as in the case of all scientific theories, is its usefulness; and the usefulness of the Minkowski geometry is demonstrated by the author in connexion with the new kinematics based on the Einstein theory of relativity—a kinematics which Euclidean geometry is powerless to express.

In discussing light and the quantum, the author introduces his theory of absorption of light and interference, an account of which has already been published in NATURE (117, 236, 1926). In this theory the assumption is made that an atom never emits light except to another atom, and one can no longer regard the one atom as an active agent and the other as a passive recipient. According to this theory, when one arranges an optical apparatus so that interference bands are produced, one not only brings it about that no light is received on the dark band, but also the light which otherwise would have fallen in the region of the dark band is not *emitted*. The author recognises that such an idea, which is really equivalent to saying that we can influence events which are already past, is offensive to our established notions of causality and temporal sequence, but he holds that we need not therefore be deterred from making use of the hypothesis so long as no actual fact of experiment or observation can be brought against it, especially since by its means "certain inconsistencies between prevailing physical ideas and the geometry which so admirably interprets the kinematics of relativity are removed." This view can of course be accepted, but does it not imply that we are here dealing merely with a mathematical device which may later have to be discarded or receive interpretation by a more complete physics?

In the concluding lecture, the author boldly, but apparently with a certain amount of trepidation, attacks the problem of life. While professing ignorance of the meaning of the term 'vitalist,' the author proclaims that "it is indisputable that many of the characteristic properties of living beings are not only far beyond the reach of existing physical science, but are not even suggested by the most remote extrapolation of the laws and theories that we have made to fit the inorganic world." Of the phenomena which have no counterpart in inanimate Nature, one of the most striking is known as the struggle for existence. In concluding his lectures the author says: "The sciences of physics and biology comprise sets of man-made postulates and laws which no more need to be compatible with one another than do the geometries of Euclid and Lobachevski. The science of physics rests upon the postulate of determinism; the science of biology, unless it is to ignore deliberately the phenomena of behaviour, must abandon this postulate and substitute therefor a postulate of choice or freedom."

The book is most refreshing to read, owing to the sense of humour of the author and the clearness with which he expresses his views, and it is also most stimulating and provocative of thought. It suffers, however, from over-condensation. The author confesses that the collection of "simple essays" has been brought "by the publishers to the dimensions of a book only by generous spacing between the lines," and he obviously expects the reader to read rather extensively between these lines. There are, however, very many people, not all of them laymen in the domains of science and philosophy, who are intensely curious concerning the subjects treated in these lectures, but will find it very difficult, if not impossible, to make the necessary interlections. May we not express the hope, therefore, that the author will place the world still more in his debt by giving to it an expansion of this excellent outline of a system of philosophy? Meanwhile, we are grateful for this smaller work.

Alex. Findlay.

Carbohydrate Metabolism and Insulin.

Carbohydrate Metabolism and Insulin. By Prof. J. J. R. Macleod. (Monographs on Physiology.) Pp. xii + 357 + 4 plates. (London: Longmans, Green and Co., Ltd., 1926.) 18*s*. net.

THIS comparatively large volume furnishes an excellent description of carbohydrate metabolism in general. This is only what might be expected from such a well-known author as Prof. Macleod, who has done so much useful work on this subject. To anybody wishing to get a fundamental idea of our present knowledge in this field of metabolism the book can be confidently recommended. Of all the volumes of literature on the difficult and evasive problem of carbohydrate changes in the animal body, the present appears certainly to be the best. It deals with the subject in a clear though fundamental manner, and embraces everything that is known as to the physiology of carbohydrate metabolism.

The book opens with a chapter on the structure of the islets of Langerhans and their cytological characteristics. This is followed by a useful description of the structural changes which the pancreas undergoes under various experimental conditions. The various mechanisms of the different forms of glycosuria are concisely discussed, followed by a complete description of glycogen and the various changes this substance undergoes in the body. Methods for the estimation of blood sugar are mentioned, and the manner of existence of the sugar in the blood is discussed briefly. The author does not accept the view propounded a few years ago to the effect that the sugar in the blood of the healthy animal is not ordinary glucose, but a very reactive modification known as γ-glucose. It is pointed out that the alleged evidence for the occurrence of γ-glucose in the animal organism is exceedingly unsatisfactory, for this substance is so labile and unstable that even if it did occur in the body, it would be almost impossible, with our present methods, to isolate and identify it.

Naturally, a great deal of the volume is devoted to a study of the action of insulin, and while this part of the book is done just as well as the rest of it, it must be admitted that a perusal of Prof. Macleod's critical compilation on this subject leaves the impression that there is yet very much to learn. The hopes held out a few years ago that the advent of insulin would solve many of our hitherto insoluble problems have been almost entirely unfulfilled. In spite of the very large amount of experimental research, both good and bad, carried out on the particular influence of insulin in the utilisation of carbohydrate in the animal body, it is safe to say that as yet but little advance has been made in this difficult field. When we consider that the products of sugar destruction are comparatively simple, and, from the chemical point of view, necessarily limited to a few substances, it is a matter for wonder that, so far, we have failed to trace the various steps through which sugar is broken down to carbon dioxide and water. It is true that some glimmerings of light have now and again appeared within the last few years, but nothing definite has so far transpired.

Insulin has, on the whole, been a disappointment so far as it has afforded any insight into the physiological processes which the body employs. Very many papers have appeared, and are still appearing, which deal with the manner in which insulin acts, but the many controversies and difficulties which have arisen seem to have been solved by the work of Dale and his collaborators, who state that insulin acts by changing some of the sugar of the body into glycogen, and by oxidising the rest of it. These authors believe that the disappearance of sugar, after insulin administration, can be accounted for by the sugar destroyed and the glycogen formed.

This means, as was to have been anticipated from the very beginning, that insulin acts when injected just as it does when supplied normally by the pancreas. The problem is, how does insulin act when it is supplied in the natural manner to the healthy individual? That problem still awaits solution, and we know little or nothing at present with regard to it.

From the clinical point of view, it would appear that insulin in several cases produces changes in the diabetic which are not obvious in the normal individual, but it is quite possible that these changes may be dependent on the difficulty of administering the optimum dose when insulin is given artificially. However, the rapidity with which several diabetic patients become abnormally fat when taking insulin, suggests that insulin probably has some direct influence on the formation of fat from sugar in the body.

To anybody interested in this fascinating though difficult subject of carbohydrate metabolism, a perusal of Prof. Macleod's volume will serve to give an exact and well-reasoned view of the present position of this subject. It would appear probable, however, that what is believed to be true to-day will undergo vast modification in the future. The subject, so far, has not yielded to attack, and whatever we write or think, it is certain that we know but little of the real facts. H. MACLEAN.

The Terminology of Electrical Engineering.

British Engineering Standards Association. Publication No. 205, 1926: *British Standard Glossary of Terms used in Electrical Engineering.* Pp. 263. (London: British Engineering Standards Association; Crosby Lockwood and Son, 1926.) 5*s.* net.

PURSUING its work of standardisation, the British Engineering Standards Association has issued a glossary in which the terms in common use in electrical engineering are defined, so as to provide engineers with a uniform nomenclature. With this end in view, the compilers frequently give a list of the synonyms actually in use, indicating their preference by heavy type, and in some instances marking others as 'deprecated.' From this point of view, the sections on composit machines (*i.e.* converters of all types) and transformers, and that part which deals with the exac uses of such terms as 'protected,' 'enclosed,' an 'flame-proof,' will be valuable in giving exac meanings to terms which have not always bee used in the same way by different writers.

As is to be expected in such an undertaking there are cases where the choice will not meet wit general agreement; particularly is it to be hope that the engineering world will not adopt th suggestion of calling the extreme range of a wav the 'double amplitude,' whilst it will be interestin to see if the terms 'active current' (the tabulate alternatives being active component, energy component, power component, and in-phase componen of the current) and 'reactive current' (for th other component) succeed in ousting their rivals We also note that the distinction between a oscillating and an alternating current is made t depend on whether the frequency is or is no dependent solely on the constants of the syste in which it flows.

As to the definitions themselves, they are for th most part adequate for their purpose, but it i doubtful whether much good is done by defining for example, the blade of a switch, and the contac jaws, in a reciprocal manner, except in cases wher it is desired to indicate that one of a number o alternatives is preferred. It is, however, in th general section that the weakest definitions occur Apart from the vexed 4π question, we find separat definitions of quantity and of charge, and each o them is logically unsatisfactory, although no doub adequate for the restricted purpose of this glossary Quantity is given as the product of current an time, whilst current is earlier defined as quantit per second. Charge is stated to be 'an excess or deficiency of electrons on a body, causing electric effect in the neighbourhood'; but definition 1102 gives th meaning of 'electron' as the fundamental unit o negative electricity. On this subject of electrica units it seems rather a pity that the term selecte for the B.T.U. should make the definition commence 'Unit of Electricity: a Unit of Electrica Energy.' It is also to be regretted that whil the numerical value of the electronic charge i quoted, and values given for the B.Th.U. in joules other useful figures, such as the ratio of the tru to the international volt, and the E.M.F. of th Clark and cadmium cells, are omitted. On would also have liked more information on th International Candle, which is here stated simpl to be a unit of luminous intensity, arrived at b common agreement between certain specified institutions. It is also to be regretted that the term 'thermo-electric effect' has been restricted to one particular effect.

Lest this catalogue of blemishes (impossible to avoid in reviewing a work in the form of a glossary) should convey a wrong impression, it must be pointed out that they concern but a small fraction of the total number of entries, most of which are very clear, and should materially assist in attaining the ideal of one definite term for each concept requiring expression. The book is excellently produced, is divided into sections, and provided with a very complete alphabetical index, in which all the terms are indexed, whether or not they are 'deprecated' in the body of the work. Misprints are very few, the following list including all that have been noted: in definition 1510 the second 'per sec.' is omitted, and in No. 1901 the figure 3·68 should be 36·8. In the index, under 'charge' the figures 1210 and 1310 should be 1201 and 1301.

J. H. A.

The People of China.

Anthropology of Eastern China and Kwangtung Province. By S. M. Shirokogoroff. Pp. vi + 162. (Shanghai: Royal Asiatic Society, North China Branch, 1925.) 5 dollars.

AN account has already been given in NATURE (Dec. 12, 1925, p. 855) of the anthropological inquiries now being conducted in China by Dr. Shirokogoroff and described by him in a series of reports. The volume already discussed dealt with the populations of the provinces of Kiangsu and Chekiang. The present work gives further information relating to the living people of these provinces as well as of Kwangtung, and in fact of the eastern part of China. It is essentially a statistical investigation, and is free from speculations as to the assumed influence of the endocrine glands in causing racial differentiation, to which particular reference was made in the previous review.

The real value of the present, like the former, report is the new data submitted by Dr. Shirokogoroff, who seems to have cast his net widely in the process of collecting both measurements of living people and comparisons from the literature of anthropology, especially many references to eastern Asia not readily accessible to students in western Europe.

By the analysis of series of measurements, the attempt is made to define different types and to estimate their relative representation in the populations of the various provinces. The commonest of these types in the northern provinces and in Manchuria is characterised by high stature (1·75 m.), a low cephalic index, and a high nasal index. In the provinces of Kiangsu and Kwangtung this type is said to be absent. It is rare in Anhwei and Chekiang. In central China (Honan) it is common, and in Chili and Shantung it is the usual and characteristic type. His second type is distinguished by a smaller stature (1·60 m.), a high cephalic index, and very high nasal index. Its geographical distribution is very wide, being the dominant type in eastern China and Korea (possibly also in Japan). It is also common among the Manchurians and the Northern Tungus.

If these results should be confirmed by further studies, they will necessitate considerable re-orientation of current views on the distribution of Mongolian types. So far, however, the conclusions are tentative. They have met with severe criticism, especially (according to this memoir) from Prof. Tschepourkowsky of the University of Vladivostok, "one of the leading sovietic anthropologists," who has asserted that types claimed to have been identified by Dr. Shirokogoroff in northern China "are a mere phantasy."

G. ELLIOT SMITH.

Our Bookshelf.

Getting out the Coal: Stripping, Underground Mining, Loading Machines, Roof Support. Compiled by Frank H. Kneeland. (Practical Coal Production, Vol. 2.) Pp. vii + 403. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1926.) 15*s*. net.

THE present volume is a continuation of a volume on preliminaries of coal mining, etc., compiled and published in the same way as the present volume, which was reviewed in these columns in June last year. Practically the same criticism that was applied to the previous volume holds good for the one now before us. It deals almost entirely with American methods and American practice, though a few pages are devoted here and there to English methods by way of directing the attention of American engineers to them, though it cannot be said that the British illustrations which have been suggested are at all typical of the best British practice.

The work is divided into four chapters: Stripping or surface mining; underground methods of mining, constituting the bulk of the book, so that more than half the text is contained in this one chapter; loading, loading machines, and conveyors; timbering and roof support. The first chapter is naturally of no use to the British colliery engineer, especially as the greater part of it is devoted to the stripping of anthracite. As regards the second chapter, it is of no use to engineers in England, and probably of but little use even to American engineers, because the most recent methods are not discussed. The chapter on loading machines and conveyors is decidedly disappointing; the compiler appears to have got his information on the subject of loaders mainly from the builders of the machines, rather than from their users, and gives the impression of not having been in touch with their practical use underground. He entirely ignores the existence of the gate-end loader which is making considerable headway in Great Britain, and omits from the discussion some of the modern American cutting and loading machines which are being tried out in West Virginia.

The last chapter on timbering, etc., again is unsatisfactory. The compiler has attempted to work out certain formulæ for determining the size of timbers to be employed; he gives one of these on p. 307, and is apparently unaware of the fact that he is repeating the same formula only slightly altered in form and in the letters used in designation on p. 331. His confidence in his own formulæ is best expressed by the statement that he solves a particular example, and shows that according to his formula "a 4⅛-in. stick will support the load"; he goes on to say, however, that "in this case it would be advisable to use a larger stick, say, 8 in. diameter."

Geologie von Europa. Von Prof. Dr. Serge von Bubnoff. (Geologie der Erde.) Band 1: *Einführung, Osteuropa, Baltischer Schild.* Pp. viii + 322 + 8 Tafeln. (Berlin: Gebrüder Borntraeger, 1926.) 22·50 gold marks.

The present volume forms the second instalment of the "Geologie der Erde," vol. 1 of Prof. E. Krenkel's "Geologie Afrikas" having been published about a year ago. The whole project is a decidedly ambitious one, for the aim is to give a comprehensive and correlative account, from the structural as well as from the stratigraphical point of view, of the geology of the earth, each continent being dealt with separately.

Prof. von Bubnoff has been faced with a task more formidable than that of any of the other contributors, so complicated is the structure of the continent of Europe, and so extensive the literature. He sets out in the first place to determine from palæogeographical considerations what are the fundamental structural divisions of the whole area, and shows how, with certain modifications due chiefly to the great mountain-building movements, the character of each region has tended to remain constant throughout geological history. He then discusses the variations in gravity over the continent, the general distribution of ore-deposits, and the present-day morphology.

The rest of the present volume is devoted to a detailed account of eastern Europe, the development of which is shown to have been independent of that of western Europe since Palæozoic times. The Ural Mountains, the Posthumous Uralides, the Russian Platform, the Baltic Shield, and the Podolian Massif are dealt with in turn, and an account given of the stratigraphy, the orogenesis the ore-deposits, and the morphology of eac region, together with references to the more important literature. As might be expected, th text makes rather solid reading, but, fortunately it is well illustrated by explanatory maps an sections. The appearance of the remaining tw volumes, which are to deal with western and wit Mediterranean Europe, will be awaited wit interest, since the complete treatise will undoubtedl fill a gap in geological literature and be of considerable use as a work of reference.

Die Ökologie der blattminierenden Insektenlarven Von Dr. Martin Hering. (Zoologische Bausteine Ausschnitte aus dem Gesamtgebiet der Zoologie Band 1, Heft 2.) Pp. iv + 253 + 2 Tafeln. (Berlin Gebrüder Borntraeger, 1926.) 18 gold marks.

Only a few months ago we had the opportunit of noticing Dr. Hering's "Biologie der Schmetterlinge," and it is seldom that an author is able t produce two works of evident scientific meri within a period of less than a year. The treatis before us is the result of the study of the specialise subject of leaf-mining insect larvæ.

A great deal of the information that lies scattere through the pages of numerous periodicals ha been critically examined and gathered together i producing this book. At the same time, Dr. Herin has incorporated much of his own studies, and ha imparted greater exactness and a more scientifi viewpoint, in what has hitherto remained an ill defined branch of entomology. In order to achiev his object he has coined a special terminolog which differentiates the various characteristi features of miners. As the names which he adopt are short and convenient, it is possible that the may find acceptance.

The book is divided into sixteen chapters, eac one being devoted to a particular aspect of th subject. Thus, Chap. i. is concerned with th definitions and the general morphology of mines Chap. ii. deals with mines in different parts o plants; Chap. iii. with 'stationary' and 'temporary' miners; and Chap. vii. discusses larva structure in relation to mining habits. Chap. x is concerned with problems relative to the nutritio of miners, and there are chapters dealing wit aquatic mines and on the parasites, inquilines, an symbionts of mining larvæ. The book is wel printed and illustrated; it is provided with a ver complete bibliography, and the price on the whol is reasonable.

A. D. I

Meteorological Office: Air Ministry. British Rainfall, 1925: the Sixty-fifth Annual Volume o the British Rainfall Organization. (M.O. 285. Issued by the authority of the Meteorologica Committee. Pp. xviii + 279. (London: H.M Stationery Office, 1926.) 15*s*. net.

For the year 1925 the rainfall over the Britis Isles was very slightly above the average and ca be taken as normal. In some districts abnormalities occurred; among the most remarkable o these was the exceptionally dry June, which wa absolutely rainless in many localities and one of the driest months on record for the British Isles as a whole. The cold and cheerless summer was the fourth summer in succession of that nature. In spite of the large number of thunderstorms, especially in May and June, there were few days with heavy falls of rain.

A special article is given showing a comparison of the fluctuations experienced at two standard stations—Oxford, fairly central in England, and Glenquoich in the western Highlands of Scotland—and maps are given showing the results of these statistical investigations, considering also their relation to other places in western Europe. A classified list appears of the papers published in "British Rainfall" in the last twenty-five years. A summary is also given of some experiments on the shielding of rain-gauges made at Valencia Observatory in Ireland. The question of over-exposure is discussed as well as insufficient exposure. The effect of wind conditions is considered upon the catches in recording gauges.

Post-Prandial Proceedings of the Cavendish Society. Sixth edition. Pp. 37. (Cambridge: Bowes and Bowes, 1926.) 2*s*. net.

THIS collection of verses began with a few songs written for 'community singing' at the annual dinners of the research students of the Cavendish Laboratory. The first collection was privately printed in 1904, and similar editions with new songs added appeared in 1906, 1907, and 1911. Some of these were of a purely ephemeral interest and were omitted in the first published edition of 1920. The present edition was published in connexion with the dinner held in celebration of the seventieth birthday of Sir J. J. Thomson. Several of the songs are tributes to him, including a "Biographical Sketch," which gives a versified account of his career up to date. The author of this, as of most of the best songs in the volume, shelters himself modestly behind the initials "A. A. R." The 'J. J.' songs reveal the extraordinarily happy personal relations which have always bound the research students to their professor, while the songs in honour of Sir Ernest Rutherford are sufficient evidence that the old tradition is being carried on. The remaining songs deal with important branches of modern physics from the electromagnetic theory to the quantum theory. All old Cavendish students will welcome the appearance of this new edition, which is greatly improved in form, and a much wider public will find it both interesting and entertaining. A. W.

Animals Looking into the Future. By Prof. W. A. Kepner. Pp. xi+197. (New York: The Macmillan Co., 1925.) 7*s*. 6*d*. net.

THE author aims, in this book, to demonstrate that in all animals, from the lowliest protozoa to man, prescience is a marked characteristic, and one that fundamentally distinguishes the organic from the inorganic world. Both mice and men have plans, and from a brief consideration of the habits and organisation of certain colonial and solitary insects, and of the structure and physiology of more lowly animals like Hydra, Microstoma, and even the protozoa, the author seeks to emphasise this point of view. Even plants look into the future. It is true that a distinction is made between the conscious prescience of man and the instinctive prescience of insects or Hydra. The author, however, in his enthusiasm for the text of his sermon, has imparted too anthropomorphic a bias to his presentation. "Therefore, in the formation of nematocysts by the interstitial cells of Hydra we see these living units sacrificing themselves in a prescient manner with reference to the welfare of the individual polyp." This quotation, which gives an idea of the author's thesis, may easily suggest conscious thought to the layman, and it is for the layman that this book is written. It is a little dangerous to attempt the popular exposition of biological phenomena in language which may convey an erroneous interpretation to the lay mind.

Contributions to the Art and Science of Otology. Lectures and Papers by Richard Lake, 1892–1925. Pp. vi + 255. (London: Macmillan and Co., Ltd., 1926.) 15*s*. net.

THIS book consists of a collection of the author's more important contributions to current medical literature extending over a period of thirty-three years. It comprises within the limits of 255 pages fifty separate items, made up of case records, clinical lectures, addresses to medical societies, and articles, more or less controversial, on current otological topics. It is the index of an industrious and intellectually active professional career, which may well be a source of legitimate satisfaction to the author, and of interest to his colleagues and to the students who have received their training at his hands. There is not much in it that is of general scientific value at the present day. So far as the scientific side of his subject is concerned, we may cite some careful observations on tuning-fork tests of hearing in various forms of deafness. The author lays emphasis on common sources of error arising from the personal factor in examiner and examinee. No doubt in the near future our estimate of the value and significance of the various methods of testing hearing will have to be recast in view of the recent introduction of more absolute methods of audiometry.

Biochemie des Menschen und der Tiere seit 1914. Bearbeitet von Dr. Felix Haurowitz. (Wissenschaftliche Forschungsberichte, Naturwissenschaftliche Reihe, Band 12.) Pp. xii + 148. (Dresden und Leipzig: Theodor Steinkopff, 1925.) 7 gold marks.

THIS little volume gives, in a handy form, short reviews of a wide selection of biochemical subjects: each is accompanied by a large number of references to the literature, which appear to have been well selected. The arrangement follows that usual in text-books of biochemistry and physiology. The volume should be of use to those who wish to look up recent work on a specified subject without the necessity of referring to the original papers.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of Nature. *No notice is taken of anonymous communications.]*

A Quantum Relation in Large Scale Electric Wave Phenomena.

It is well known that associated with a medium containing free electrons of mass m and charge e there is a definite critical frequency ν_e where $\nu_e^2 = \frac{Ne^2}{\pi m}$. This frequency is characterised by the fact that electric waves of frequency less than ν_e cannot travel through the medium.

The group and phase velocities of waves of greater frequency than ν_e are given by the relations:

$$V_{\text{phase}} = \frac{c}{\sqrt{1 - \frac{\nu_e^2}{\nu^2}}},$$

$$V_{\text{group}} = c\sqrt{1 - \frac{\nu_e^2}{\nu^2}},$$

so that they tend to ∞ and 0 respectively as: $\nu \longrightarrow \nu_e$.

This relation:

$$\nu = \nu_e \text{ or } \frac{Ne^2}{\pi m\nu^2} = 1,$$

which determines the critical frequency of the medium, can be expressed in a way which connects it up with the quantum theory. In a paper in the *Philosophical Magazine* (July 1926, vol. 2, p. 267) I showed how to calculate the ratio $\frac{4\pi h\nu}{\beta^2}$, which is the ratio of the total energy of a quantum (engaged in an encounter with an electron) to the energy per unit volume. This ratio must therefore be of the dimensions of a volume which, for want of a better expression, was called "The Volume Occupied by the Quantum."

The expression which represented this quantity was found to be:

$$\frac{e^2}{\pi\nu^2 m_e} = V \text{ say,}$$

so that the relation giving the critical frequency can be expressed in the simple form $NV = 1$. Since $1/N$ is the average volume occupied by each electron, we may say that the critical frequency occurs when this is such that the 'volume occupied by the quantum' is equal to the average volume occupied by each electron. In order to conform with the ideas of statistical mechanics, of which long-wave propagation appears to be an example, I prefer to consider that $NV = \nu_e^2/\nu^2$ represents the probability of a direct hit of the quantum and electron, or more precisely the fraction of quanta per unit volume which are in collision at any instant with the electrons in that volume. In the case of the critical frequency this probability is unity, and the relations of quantum mechanics gives a justification for the use of this description. For the analysis of the 'Compton scattering' shows that when a direct hit occurs the momentum given to the electron $M = \frac{h\nu}{c}(1 - \cos\theta)$, where θ is angle of scattering; the average of which may be considered to be: $h\nu/c$ the momentum in the wave.

It follows that when the probability of a direct hit is unity all the wave momentum will on the average be given up to the electrons and the wave can travel no farther, this state of affairs resulting in the zero group velocity which occurs at the critical frequency.

In one respect this analysis seems to shatter the picture of a quantum as an objective particle of radiation, for such a picture would inevitably imply that the probability of a direct hit should be jointly proportional to the radiation energy density or density of quanta and the electron density, whereas the foregoing analysis shows this probability to be independent of the density of quanta.

This aspect of the quantum theory has already been pointed out by Eddington in his discussion of Einstein's derivation of Planck's law of radiation ("The Internal Constitution of the Stars," p. 56).

T. L. Eckersley.

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Marconi Works, Chelmsford.

Non-Magnetic Films of Iron, Nickel, and Cobalt.

A year and a half ago one of us (Ingersoll and De Vinney, *Phys. Rev.*, 26, 86, 1925) reported the results of some experiments on films of nickel cathodically sputtered in hydrogen at a pressure of 1 mm. or less. These films as produced were entirely non-magnetic, showing no tractive effects in a strong magnetic field. Upon heating to about 350° C. for a few minutes, however, they become strongly magnetic.

We have since continued this work on nickel and extended it to iron and cobalt, and find that, while it does not seem possible to produce non-magnetic films of these latter metals in hydrogen, they can be made in helium. Argon has also been used as a residual gas with nickel. In all cases heating for a few minutes to 350° or more in a vacuum—or, for that matter, passage through a bunsen flame in air—makes films of these three metals strongly ferro-magnetic.

The crystal structure of these films has been investigated by the X-ray method (iron and tungsten anticathodes). In the original work on nickel the evidence was to the effect that, while the film after heating showed the normal lattice for nickel, as originally produced it was amorphous, giving no clear evidence of crystal structure. In our recent work, however, we find—using an improved technique, whereby the crystal structure is determined without removing the film from the glass—that the film as produced (*i.e.* non-magnetic state) has in general the same crystal structure as after heating but *with a larger lattice spacing*. The distension or swelling may be so much as 20 per cent. In most cases the lattice shown by the film after it has been heated and rendered magnetic is the normal one for the metal: the exceptions may be explained on reasonable grounds.

The basis on which we are seeking to explain these facts is the occlusion by the metal of large amounts of the residual gas, *i.e.* hydrogen, helium, or argon, during the process of sputtering. Palladium, as is well known, absorbs in favourable circumstances hundreds of volumes of hydrogen, and, as has been shown (McKeehan, *Phys. Rev.*, 21, p. 334, 1923), this results in a lattice distension of some 2 or 3 per cent. It is true that it is a long step from this to the 6 to 20 per cent. distension we have found in many cases—and this too in metals such as iron, nickel, and cobalt, which are by no means so notable in their gas-occluding properties as palladium; nevertheless, it is the only explanation we can offer at this time.

If the presence of such large volumes of gas in these non-magnetic films be granted, although the direct experimental proof of its existence seems difficult because of the very minute amount of material in a film a light wave or less in thickness, it is of interest to inquire if it is in the form of a chemical compound with the metal or not. This must of course be answered eventually, if at all, on the basis of proved stoichiometrical proportions. We cannot decide this at present, but we can, however, adduce certain evidence. Each of the three cobalt films sputtered in helium had exactly the same crystal dimensions—20 per cent. increase above the normal face-centred cubic cobalt (the cathode was a mixture of face-centred cubic and hexagonal)—in spite of somewhat different sputtering conditions. All of the seven iron films sputtered in helium had exactly the same crystal dimensions, apparently a swelling of nearly 22 per cent. above the normal. Ten different specimens of nickel, sputtered in different gases, had a common distension of 6 per cent., although with this metal there were other values which occurred in some specimens and not in others. It was possible in the above cases to reduce, by controlled heating, part of the specimen to the pure metal leaving the rest unchanged, as shown by the X-ray picture which showed both forms present at once. This is fair evidence against the idea of simply a solution of the gas in the metal. The case seems to be somewhat different from that of palladium: we sputtered this in hydrogen and found various distensions up to 3 per cent. It was possible, by suitable heating, to reduce the distension, *i.e.* the gas in the palladium, by any desired amount.

We regard this as evidence of a chemical or at least quasi-chemical union of the metal and the gas. Compounds with hydrogen would of course be possible, and with helium and argon at least not unthinkable. The loss of magnetism is possibly to be associated with a changed electron distribution in the metallic atom, due either to the influence of the chemical combination or simply to the increased distance of the atoms apart. (See also L. C. Jackson, *Phil. Mag.*, **2**, p. 86, 1926.)

We have been at some pains to forestall the most obvious point of criticism, which would be to the effect that small traces of oxygen in the residual gas might cause these metals to sputter as (non-magnetic) oxides which reduced on heating to the pure metal. Some colour is lent to this point of view by the fact that the lattice spacing of cobalt as deposited is almost exactly that of cobalt oxide. There are several reasons why we do not believe this view tenable: (1) We have taken great pains in purifying the gases, particularly as regards removing hydrogen and oxygen from the helium and argon: there was probably a trace of nitrogen in each. (2) If the metal, *e.g.* cobalt, is sputtered as an oxide, it must be of such a character as can be reduced to the metal by heating in a vacuum for a few minutes to, say, 350° C. This possibility is contradicted by chemical evidence, and experiments we have made on cobalt oxide indicate that such reduction is impossible. (3) There are minor differences between the lattice shown by the original cobalt films and cobalt oxide which clearly separate them. It would seem, nevertheless, as if we had here a cobalt helium compound very like cobalt oxide.

The work is to be continued with certain improvements, such as the use of fused quartz instead of glass, on which to deposit the films: also with better means for thorough outgassing and for extreme purification of the residual gases.

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L. R. Ingersoll.

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Dec. 18.

The Spectra of NH Compounds.

It is well known that the flame of ammonia emits several characteristic bands. The appearance of the bands is strongly influenced by the temperature of the source. Thus the spectrum of the cool flame of ammonia is dominated by the diffuse so-called α-group in the yellow region. In the spectrum of a hot source of ammonia, burning in the electric arc, the β-group with its intensity maxima at λλ 3370, 3360 is photographically by far the most intense. From investigations on the exciting conditions and on the structure of these bands, one may suppose that the very complicated α-group is emitted by the excited NH_3 or NH_2 molecules, or a mixture of both, as one can distinguish with some degree of certainty two different systems in α. Judging from some very distinct structural relations holding between the β-group and the long series of known hydride spectra, we refer the origin of this group to the NH dipole. This will be discussed later. Other bands of the ammonia-oxygen flame are referred by Eder to NO compounds. Very recently, K. Gleu, in an interesting paper on the chemi-luminescence of chlorine trinitride in hydrogen trinitride (*Zeits. f. Phys.*, 38, p. 176, 1926), reported some new bands of nitrogen hydride. From their symmetric positions around the β-group and their comparatively simple structure we suggest that they also belong to the spectrum of the NH dipole.

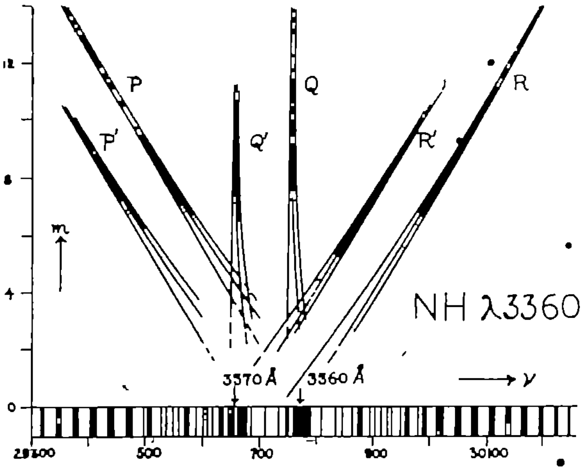

Fig. 1.

We have lately studied the structure of the β-group, using Fowler and Gregory's measurements (*Phil. Trans. Roy. Soc. London*, A, 218, p. 351, 1919) as well as our own, taken from spectrograms of high dispersion (1 Å.U. = 1·2 mm.). Fig. 1 gives a rough view of the system arranged in a ν-m diagram. The characteristic triplets on both sides of the intensity maximum at λ 3360 are shown as P- and R-branches, while the intensity maximum itself is supposed to be made up of the overlapping lines of the corresponding Q-branch. The long-wave component (Q_1), especially in the Q-triplets, thus causes the region which is still unresolved with a very high dispersion at λ 3360·31. As in the cases of many other band spectra, this arrangement gives rise to a 'combination defect' which has to be explained by assuming a separate set of rotational terms for the Q-branches *vis-à-vis* with those of the P- and R-branches. From a closer analysis of the spectral terms, it appears that the initial state contains an electronic triplet, while the final state is a singlet. The final state, however, includes a rotational triplet of unknown nature in which the very small term separation increases linearly with m ($\sim 0{\cdot}010\, m$). Accurate figures for the electronic frequencies cannot be obtained (~ 29750 cm.$^{-1}$) owing to the difficulties in computing the series down to their origins. If we denote by σ and ϵ the quantum numbers of the total electronic angular momenta parallel and perpendicular to the figure axis of the dipole, it appears from the analysis that the initial term contains distinct σ, ϵ components, while in the final state, $\sigma = 0$, $\epsilon = \frac{1}{2}$. The nuclear spacing of the molecule in its final state is $r_e = 1{\cdot}10 \times 10^{-8}$ cm.

The above statements are in agreement with the hypothesis on the appearance of Q-branches in band spectra, and also point to some clear relations holding between this spectrum and those of the hydrides as they appear in the periodic table. All the known hydride spectra are associated with electronic transitions of the type $S \longrightarrow S$ or $S \rightleftarrows P$. These two types can sometimes be distinguished from each other by the fact that bands of the first type contain only P- and R-branches, while those of the second type have Q-branches in addition. This seems to be a general rule holding for all band spectra. Consequently we assign to the β-group of the NH spectrum a ${}^3P \longrightarrow {}^1S$ transition, where ${}^3P$ separations should agree in magnitude with those in the spectrum of the preceding atom, here carbon, which spectrum, however, is still imperfectly known.

While the spectrum discussed above apparently forms the spectrum of the non-vibrating molecule ($n_1 = 0$, $n_2 = 0$), the secondary maximum at λ 3370 with the faint triplets on both sides of it can be explained in detail as the corresponding first vibration spectrum ($n_1 = 1$, $n_2 = 1$).

The triplets in the β-group are of the same type as those forming the bands of the second positive group of nitrogen. It is, however, interesting to note here that the regular alternation of intensity observed in the short-waved component (a narrow doublet) of the N_2 triplets has no counterpart in the NH triplets, the components here being all single so far as can be judged from our spectrograms. This also confirms the assumption of Mecke, according to which such anomalies are to be found in the spectra of symmetric molecules as H_2, He_2, HCCH, N_2 (see also Slater's hypothesis on this problem, NATURE, April 17, 1926, p. 555).

E. HULTHÉN
(Intern. Board of Educ.).
SUNAO NAKAMURA.

Physics Department,
University of Michigan, Dec. 20.

Icebergs in Relation to Water-Temperature.

IN an article in NATURE of Nov. 20, p. 750, which discusses means of enabling a vessel to detect the proximity of icebergs at sea, a remark is made which indicates that the attempt to do so by means of the temperature of the water has proved unavailing. When the conditions are considered it could scarcely be otherwise. I was impressed by this during two seasons spent in investigating the currents in Belle Isle strait, in 1894 and 1906, when the matter was looked into.

In that strait the surface water may warm up to 57° F. in summer, while the deeper water remains little above freezing point. Hence, with a heavy wind across the strait, the surface water may be driven to the leeward shore, allowing the cold under-water to come up to the surface. A vessel on its way through the strait might thus find the temperature so low as 45° or even 35° in the summer time, which is a large change compared to any lowering of the temperature by ice.

It is also to be noted that in currents at sea the velocity decreases from the surface downward; and an iceberg which may have a draught of 150 feet to 300 feet (as shown by the depth in which it grounds) will move at the average velocity of the current between the surface and that draught. Accordingly, there is normally a flow of surface water past an iceberg, due to difference of velocity, when it travels in a marine current. The only chill to the water is therefore in the tailing or wake, on one side of the iceberg, in the line of flow. Unless a vessel approaches towards that side it would detect no difference in the water temperature.

The amount of chill in the region of Belle Isle strait, in water which is already cold, was investigated with a boat, going close up on all sides of the icebergs. When the general surface temperature was 35·5° F. the water tailing from an iceberg was 35°, while on its other sides no difference was found. A small berg aground in a bay in which the surface temperature ranged from 34° to 34·5°, chilled the water to 33·5° close around it. In the case of a large iceberg (780 feet by 290 feet at the water-line, and aground in 57 fathoms) the water temperature, 37°, did not vary within 130 feet of it. Such small differences could not be considered as an indication of practical value, especially when within a few hundred feet of the bergs.

Nevertheless, Dr. H. J. Barnes was hopeful of more definite indications by means of his highly sensitive thermometer, especially near the meeting-place of the Labrador Current and the Gulf Stream, where the water is warmer and almost motionless. But a further feature was encountered under these conditions; for the water chilled by the iceberg sank vertically down from its sides. With an iceberg in relatively warm and still water there is thus theoretically a movement of the surface water inward towards the berg, instead of any spread of chilled water around it. The lowered density of the sea water due to dilution from the melting ice does not seem to counteract this, because of the rapid rate of increase in the density of water with fall of temperature.

When such conditions are understood, the uncertainty of any temperature warning against floating ice will be appreciated.

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Dec. 24.

The Chromosome Number in *Dactylis glomerata* (Cocksfoot).

IT is only recently that the attention of cytologists has been directed to the ascertaining of the chromosome number in the herbage grasses. In a letter to NATURE of Dec. 11 (vol. 118), p. 841, Mr. Gwilym Evans states that he has discovered the number in the Lolium spp. and has given a tentative estimate of the number in the two varieties of *Festuca elatior*.

Whilst engaged at the Welsh Plant Breeding Station, Aberystwyth, in carrying out preliminary investigations on the genetical behaviour of *Dactylis glomerata*, it was thought expedient to ascertain the chromosome number of this species. The nuclear divisions, both somatic and meiotic, have been extensively investigated; the root-tips being selected as the most promising material for an examination of the somatic, whilst the meiotic divisions were studied in the anther.

The root-tips were fixed in Flemming's Solutions, in some cases a little modified. For the fixation of the anthers, Flemming's Solutions proved entirely unsuitable. Excellent fixation was, however, obtained with Bouin's Picro-formol and with Allen's modification of this solution. Belling's Aceto-carmine gave only indifferent results as a medium for chromosome counts on this species.

The conclusions drawn are entirely based on the examination of permanent slides of the root-tips and of the anthers. The number in *Dactylis glomerata* is clearly established as being twenty-eight in the diploid somatic nucleus of the root-tip and fourteen in the haploid nucleus. The count in the root-tip cells was made when the chromosomes were arranged equatorially on the spindle, and before the separation of the daughter chromosomes. In the case of the heterotype division it was much easier to count the univalents when in mid- and late-anaphase. Fourteen univalent chromosomes were readily distinguished. This number was again to be seen in the homotype division immediately following, the best stage for counting being the equatorial plate stage, just previous to the commencement of anaphase.

It is thus established that the chromosome number in *Dactylis glomerata* is fourteen in the haploid and twenty-eight in the diploid generation.

The investigation of the chromosome number in *Arrhenatherum avenaceum* and *Phleum pratense* is now proceeding. It is as yet too early to state definitely the number obtaining in these two species, but an examination of the root-tip of *Arrhenatherum avenaceum* (the indigenous form with swollen basal internodes is the one hitherto examined) enables me to state that the diploid number in this species is in the neighbourhood of forty.

It is hoped in the near future to state definitely the chromosome number of both these species.

J. GRIFFITHS DAVIES.

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Hyperfine Structure in the Neon Spectrum.

IN an investigation of the neon spectrum I have found that all lines, which arise from an *s*-term, have a component of shorter wave-length. The intensity of the satellite ranges from one-fourth to one-tenth that of the main line (according to a rough estimation). The separation of the components varies with the *s*-term concerned; for a $2s_2$ term it is 0·076 cm.$^{-1}$; for a $2s_3$ term, 0·054 cm.$^{-1}$; for a $2s_4$ term, 0·056 cm.$^{-1}$; and for a $2s_5$ term, 0·058 cm.$^{-1}$. The structure is apparently due to a multiplicity in the *s*-levels. There are also evidences of a fine structure in the *pd* series lines, but complete resolution has not yet been attained.

The fine structure of the neon-lines has a certain importance for their use as wave-length standards. In an inhomogeneous discharge the intensity of the main line will be weakened by self-reversal more than that of the satellite; thus with incomplete resolution of the structure the maximum intensity will be displaced towards shorter wave-lengths by increasing self-reversal. The fine structure must also be considered in absorption and intensity measurements. The question whether the neon isotope of atomic weight 22 emits the component of the neon lines is to be decided by an investigation of the Zeeman effect for the fine structure.

Structure of the Mercury Line λ4916.—This line has hitherto been found simple by all observers: it consists, however, of five components separated from the strongest members by the following intervals:

$$+0{\cdot}098 \text{ cm.}^{-1}\ (2),\ +0{\cdot}056\ (4),\ \pm 0\ (10),\ -0{\cdot}066\ (3),\ -0{\cdot}121\ (5).$$

Structure of the D_3-Line of Helium.—At the suggestion of Prof. Paschen the structure of the lines of orthohelium has been investigated. The intensity measurements for the line λ5876 ($2^3P_i - 3^3D$), which is usually regarded as consisting of two components with intensities 1 and 8, made it seem probable that this line was really a triplet with relative intensities 5 : 3 : 1, of which the two strongest components had not been resolved (MacNair and McCurdy, NATURE, 117, p. 159, 1926). The theory of Heisenberg (*Zs. f. Phys.*, 39, p. 499, 1926) requires a separation of the components ($^3P_2 - {}^3P_1$) of about 1/10 ($^3P_1 - {}^3P_0$). With the aid of the Fabry-Perot interferometer and a direct current discharge at the lowest possible pressure, the apparatus being cooled with liquid air, I have succeeded in resolving the components $^3P_2$ and $^3P_1$. The resolution was improved when the discharge tube was immersed in liquid hydrogen. The frequency differences are: $^3P_2 - {}^3P_1$, 0·075 cm.$^{-1}$; $^3P_1 - {}^3P_0$, 0·98 cm.$^{-1}$. The relative intensities have not been measured, but they apparently agree with expectation.

G. HANSEN.

Physikalisch-Technische Reichsanstalt,
Berlin, Jan. 10.

(Translated by R. A. Sawyer.)

Spinning Electrons and Protons.

THE remarkable results obtained within the past fifteen months by employing the spinning electron in Bohr's atomic model suggest the question whether it may not be necessary to suppose that the proton also is capable of a quantised spin. Although the analytical difficulties in applying the new quantum mechanics to this problem may be considerable, they may not be too great to be overcome by mathematicians. There seem to be several arguments in favour of such a hypothesis. If, as is generally assumed, the proton is the positive electron, it seems natural to suppose that if the negative electron can spin with unit angular momentum the positive electron may do the same. Again, it may be easier to understand the structure of a complex nucleus if the units of which it is composed can act as elementary magnets. Prof. Duane has attempted to explain corpuscular emission from a radioactive nucleus on these lines. Finally, recent experiments on the deflection of protons and alpha particles in collision with an atomic nucleus seem to lend support to the idea of a magnetic field in the vicinity of a nucleus.

A spinning electron is one example of a *magneton*. My main object in this letter is to remind readers of NATURE that a quantised magneton was first described in these columns (vol. 92, p. 165, Oct. 9, 1913) by Prof. G. B. McLaren, a victim of the War. "The natural unit of angular momentum," postulated by Nicholson and employed by Bohr, "actually exists. It is the angular momentum of the magneton." It is true that McLaren's magneton is in one sense not spinning, for he rejected entirely the idea of magnetic or electric substance, and the angular momentum is located in the electromagnetic field. It is true also that he assumed his magneton to represent a *positive* electron, but this choice was, as he himself pointed out, an arbitrary one (*Phil. Mag.*, vol. 26, pp. 667-8, 1913). The essential fact remains that the idea of a magneton having angular momentum determined by the quantum condition was clearly stated, and was thereafter employed without question by other writers. It may be found, for example, in my paper on an atomic model with a magnetic core (*Phil. Mag.*, vol. 29, p. 719 footnote, 1915), in connexion with a positive electron, and in the discussion of the 'ring electron' (or Parson magneton) at the Physical Society of London on Oct. 25, 1918 (*Proceedings*, vol. 31, p. 61, 1919).

It is almost needless to add that there is no intention of detracting in any measure from the credit due to those who have recently been so successful in applying the spinning electron in connexion with the Bohr atom. There is satisfaction in finding that ideas for which the time was not ripe ten or more years ago now have a wide field of application, and are accepted by the leaders in physics, who were at one time unwilling to ascribe structure of any kind to the electron.

H. S. Allen.

The University, St. Andrews.

Rotation of Dielectric Bodies in Electrostatic Fields.

The rotation of dielectric bodies when suspended between the knobs of a Wimshurst machine was first observed by me about a year ago. Since then the phenomenon has been studied by Messrs. L. G. Vedy and G. Gowlland and other pupils of mine. Experiments illustrating the phenomenon were shown at the recent Physical and Optical Societies' exhibition at the Imperial College of Science and Technology, particulars of some of which are given below.

Pieces of paraffin wax (including a sphere of 5 cm. radius), ebonite, sealing-wax, and a glass beaker rotated when suspended between the knobs of a Wimshurst machine. A covering of metal foil prevented rotation.

Brass spheres covered with paraffin wax rotated, the greatest rate being attained by the sphere with the thickest wax layer. Better results were obtained with bodies mounted on bearings (steel needles in glass sockets) as this arrangement prevented the bodies from swaying and striking the knobs.

By using an alternative gap it was shown that rotation did not occur in the absence of a brush discharge. Also sparking usually decreased the effect.

The presence of a charge on the bodies was shown by using a proof plane and an ordinary gold leaf electroscope. When the paraffin wax sphere was mounted symmetrically between two nearly similar knobs the charge was shown to be very small.

When the bodies were suspended inside a glass beaker or between ebonite plates, which shielded them from the discharge, rotation did not occur; but the ordinary orientation phenomenon was quite marked.

The general conclusion arrived at so far is that the phenomenon is due to the effect of the discharge, but that it is not wholly a surface effect. The influence of the presence of moisture on the surface and of the air surrounding the bodies, *inter alia*, deserve careful examination and further experiments are contemplated.

S. W. Richardson.

The Royal Institution,
21 Albemarle Street, W.1,
Jan. 9.

Two-way Communication with the Antarctic.

Contact with the Norwegian whaler, *Sir James Clark Ross*, call sign AQE, by the south shore of the Ross Sea, 78° 30′ south latitude, was obtained by C. W. Goyder from the Mill Hill School station, 2 SZ, on Jan. 30, and the messages exchanged constituted the first two-way communication with the Antarctic. Contact was again established at 8.30 A.M. to-day with the double object of putting the whaler in touch with a Norwegian station and of getting particulars of the ship *C. A. Larsen*, with the call sign ARDI, which is within a few miles of AQE.

Two-way working was easy and expeditious, and the first object was partially secured, for the signals of LGN (the Bergen Radio Coast station) and of AQE were both of good strength here. They were unable to hear one another, but an arrangement was made with each that they should attempt to get in touch with one another at 7.30 A.M. to-morrow (Feb. 7). Meanwhile AQE reports having been in touch yesterday with LA.IX (J. O. Berven, Stavanger).

The ship ARDI was thought to be a scientific expedition because the north-bound expedition into Norwegian waters, organised last summer from Cambridge, had the call sign ARDS, but was reported this morning by AQE to be another Norwegian whaler in their vicinity. ARDI was heard calling, but communication was not established. Direction-finding work, alluded to by AQE, is being carried on for the purpose of keeping in touch with the whaling boats in foggy weather.

W. H. Brown.

Mill Hill School,
London, N.W.7,
Feb. 6.

The Fayum Lakes.

The question of silting which is raised by Mr. G. W. Grabham (Nature, 118, 911, 1926) depends on the velocity of the water. In water that is slackening, silt will be dropped; but if the flow is quickening, it will be carried on. In the case of the Fayum channel an inflow during two or three months had to make up for four or five feet of evaporation and also a previous outflow over a large area. As the water in this six miles of channel had therefore a gradient much greater than that of the Nile, it is unlikely that any silting would be caused during the inflow. During the stationary periods only suspended silt would be dropped, which only amounts to one inch in 15 or 20 years. During the outflow no rolled silt would be carried, as it would have slipped into deeper water in the lake. It does not therefore seem likely that any fluctuations of level could be caused by silt obstruction. Two queries that are asked may be noted here: (1) The high level taken appears to be due to a pre-human estuarine condition of the Nile; (2) there is no question about the sources of the flints which I bought in the Fayum, as they are like those found there, and none in similar condition are found in the Nile valley.

Flinders Petrie.

Tell Jemmeh, Gaza.

The Supposed Law of Flame Speeds.

Mr. A. G. White, in his letter in Nature of Jan. 8, p. 51, correctly recalls the fact, which we discussed fully in our original publications in the *Journal of the Chemical Society*, that deviations from the law of speeds may be expected if one of the combustible gases in a complex mixture interferes with the burning of another. The deviations are, however, small and their nature can be predicted.

The behaviour of mixtures, near the limit of inflammability, containing ether vapour or carbon disulphide, to which Mr. White refers, was considered during the discussion of Prof. Jorissen's paper at the meeting of the Faraday Society in June. We do not attach any importance to such mixtures from the point of view of the law of speeds, for the reason that they exhibit the peculiar phenomena of the 'cool flame' (cf. White, *J.C.S.*, 115, 1462, 1919), which is quite distinct from a normal flame.

Wm. Payman.
R. V. Wheeler.

Safety in Mines Research Laboratories,
University, Sheffield,
Jan. 12.

Matrix and Wave Mechanics.

By R. H. Fowler, F.R.S.

In an article on spinning electrons (Nature, Jan. 15, p. 90) it was stated that recent progress in atomic physics is mainly due to two primary ideas: the use of a better model of the electron and of a better formal mechanics more suited than classical mechanics to the description of atomic phenomena. The changes and successes consequent on the adoption of this new model of the electron have already been described. We shall try here to give some sort of description of the ideas of the new mechanics and some of the successes to which they have led. We shall try at the same time to exhibit the two independent lines of thought which have led separately to the same new system of mechanics, but by such widely divergent paths that they have justifiably received the different names of *matrix mechanics* and *wave mechanics*. The equivalence of these two systems is perhaps the most striking and satisfactory feature of the present development.

The really fundamental features of atomic systems, as analysed with the help of the older quantum theory, are described in Bohr's first two postulates—the existence of stationary states and the frequency relation $E_1 - E_2 = h\nu_{12}$. Of these, the first is perhaps the most fundamental characteristic of all, for it is this characteristic, properly viewed, which imposes on us the particular change of the laws of mechanics which has had to be made. To describe an atom and its interaction with radiation we may agree (apart almost from all theory) that we must have (1) a set of stationary states, (2) a set of interconnexions between the stationary states which we may call transition probabilities. Collision interactions have proved harder to analyse with certainty than radiative, but we all agree that they fit perfectly into the same scheme. Our requirements, therefore, are very different from anything that can be satisfied by a system of particles obeying classical dynamics. Such systems do not have discrete stationary states. This difficulty was provisionally turned by Bohr by his third postulate ($J_k = n_k h$) which, of course, had striking successes. But these were only partial, for though the postulate gives us stationary states it cannot give us transition probabilities, except on occasions by temporary devices of interpretation based on the correspondence principle. Transition probabilities are essentially connexions between two states, whereas all the characteristics of a classical motion are functions of the one state alone. In short, a classical system in any (multiply periodic) state can be fully described by Fourier series, the coefficients and fundamental frequencies of which are functions of the parameters defining the state. An atom cannot be so described. Its coefficients must always be functions of two states, not one. Now that we know the answer it seems (as it should) very obvious—it is not a Fourier series or one-dimensional array of periodic terms with constant coefficients, but a matrix or two-dimensional array of such terms which is required to describe the atom. Any term of such an array depends on two integers m and n, defining the two states of the atom which the term connects or to which it belongs.

It may be helpful to interpolate here a few remarks on matrices. Matrices were introduced into algebra by Cayley, and form a branch of that subject interesting in itself, but hitherto not very familiar to physicists. The matrices with which the physicist is now concerned are, like determinants, square arrays of symbols, but, unlike the determinants, the matrix is not multiplied out. Instead, each symbol or term is regarded as a constituent member of the whole matrix. Thus, if we say that two matrixes are equal, we mean that each term of the first is equal to the corresponding term of the second. Matrices can be handled by a set of algebraic rules rather like the rules of the algebra of ordinary numbers. Many results go over into the new calculus unaffected, but there is one striking difference. The law of multiplication, which, loosely speaking, is that by which two determinants are multiplied together, is non-commutative—when matrix x is multiplied by matrix y the result, xy, is a matrix of which the terms are *not* the same as those of yx. The difference between these products provides exactly the necessary gap in the algebra into which the quantum theory can insert itself.

The question then arises, can one formulate a dynamics of matrices which is a natural generalisation of classical dynamics with classical dynamics as its limit, and yields rules for calculating the terms of any relevant matrix just like the classical rules for calculating any term of a Fourier series? Something, of course, must be given besides the laws of dynamics—that something is classically the potential energy function of the system, giving the field of force in which the particles of the system move, and we may demand that the same data shall suffice in the new form. This is equivalent to asking that everything shall be derived by direct unambiguous calculation from the Hamiltonian equation of the system, using generalisations of the classical laws. The quantum conditions of the older theory disappear and the essential h now enters the equations via the new non-commutative multiplication of conjugate canonical variables p and q, in the form

$$pq - qp = \frac{h}{2\pi i} \quad (i = \sqrt{-1}).$$

The answer to the opening question of the paragraph is, yes! Everything seems to work out as it should, as the work of Heisenberg, Born, Jordan, Dirac, and Pauli has abundantly shown.

The need for the matrix mechanics can nowadays perhaps be put forward as convincingly as possible in the manner adopted above, which shows that its constructs have direct physical counterparts. Every term in a matrix represents something ideally observable. Heisenberg was originally led to formulate the matrix mechanics by a deliberate development of a demand for ideal observability of the counterpart of every construct, a demand which we have just seen to be satisfied by the matrix mechanics. He pointed out that the selected mechanical orbits of the older theory cannot satisfy this demand, because they cannot even ideally be directly presented to us for measurement. On the other hand, the frequencies and intensities of the light emitted, scattered, or absorbed by an atom, are observable in just this way. The older theory tried with partial success to derive the observed frequencies and amplitudes from the abstract theoretical ones. Heisenberg's new method was to do away entirely with every theoretical construct which could not be directly related to an observable property of the atom. Perhaps the distinction set up cannot always be rigidly maintained. It served at least to suggest to Heisenberg that we should stop trying to *interpret the results* of classical calculations and instead should *re-formulate the equations* of the motion, and re-formulate in such a way that every symbol has a physical meaning, just as in an astronomical problem in the classical mechanics. Physical meaning is no longer to be confined to interpretations of the final result. Since the matrix is the mathematical construct with the properties of any natural atomic co-ordinate, Heisenberg's idea led at once to the formulation of the matrix mechanics.

An entirely different point of view has been developed by Schrödinger. Following up the speculations of L. de Broglie, in which he drew an illuminating analogy between the free motion of particles such as electrons and groups of plane waves of a special type, Schrödinger came to examine more closely than before the analogy between mechanics and optics which formed in fact the basis of Hamilton's whole treatment of mechanics. The analogy due to Hamilton is that between the dynamics of particles and geometrical optics, let us say between the paths of particles and of light *rays*. We all know, however, that the propagation of light can only be adequately discussed by the optics of rays so long as the wave length of the light is very small compared with the dimensions of every obstacle encountered. Once this condition is broken diffraction effects occur, and we need the *wave* theory of physical optics with which to describe the phenomena. To this breakdown of the *ray* theory of light there has been hitherto no Hamiltonian analogy. In setting out to find such an analogy Schrödinger has formulated what we now call the wave mechanics. We shall not attempt here to describe his arguments but only the results. Instead of thinking of an atom as a set of particles, we retain from the particle picture only the potential energy V, and the masses of the particles, m. The atomic motion can be derived from a wave equation of the usual type

$$\text{Div. grad. } \psi + \frac{4\pi^2\nu^2}{u^2}\psi = 0.$$

In this equation u is the phase-velocity of waves of frequency ν, and ψ and its operators must probably be taken to refer to the configuration-space of the whole system, of dimensions equal to the number of freedoms. The Hamiltonian analogy demands, moreover, that u, E, the energy, and ν shall be connected by the relations

$$\nu = \frac{E}{h}, \quad \frac{1}{u^2} = \frac{2(E-V)}{E^2}.$$

A universal constant of action h enters naturally into the analogy; that it has exactly Planck's value is of course only fixed at a later stage. The resulting partial differential equation,

$$\text{Div. grad. } \psi + \frac{8\pi^2}{h^2}(E-V)\psi = 0, \quad . \quad . \quad (1)$$

must be conformed to by all wave forms which correspond to states of the atomic system with energy E. The wave function ψ must naturally be subjected to continuity and boundary conditions. To represent a possible stable state of the atom it is natural to suppose that ψ must satisfy (1) and besides be one-valued, bounded, twice differentiable over the whole configuration-space, and vanish at infinity. So far there has been no mention of discrete states. Any value of E would be admissible for which a suitable ψ exists. But we come now to the most beautiful point of Schrödinger's theory, for it appears in general that suitable ψ's only exist for a set of discrete values E_n of E, perhaps together with continuous ranges of values as well. The E_n are the energies of the various stationary states and the corresponding ψ_n the wave functions of these stationary states which specify what the atom is then doing.

For the simplest example let us take the linear harmonic oscillator. The wave equation then becomes

$$\frac{d^2\psi}{dx^2} + \frac{8\pi^2 m}{h^2}(E - 2\pi^2\nu_0^2x^2)\psi = 0,$$

where ν_0 would be the classical frequency of the oscillator. The smallest value of E for which a satisfactory ψ exists is $E_0 = \frac{1}{2}h\nu_0$, and then

$$\psi_0 = e^{-2\pi^2 m\nu_0 x^2/h}.$$

We observe that ψ_0 never vanishes, so that the corresponding wave is of infinite length and has no finite nodes. The next solution is $E_1 = \frac{3}{2}h\nu_0$, and then

$$\psi_1 = 4\pi\left(\frac{m\nu_0}{h}\right)^{\frac{1}{2}} x e^{-2\pi^2 m\nu_0 x^2/h}.$$

The wave has now one finite node at $x = 0$. The following values of E are $E_n = (n + \frac{1}{2})h\nu_0$, and the corresponding ψ_n have each one more finite node, so that the wave-length of the atomic oscillation gets shorter as n increases, and tends to zero as n tends to infinity.

For the earlier values of the set E_n it is impossible to speak of orbits and point electrons. For the later values the behaviour of the simple example above is general. The wave mechanics then degenerates, so that from a group of waves of various frequencies and directions we can build up a small bundle of waves, in phase only in the immediate neighbourhood of one point. This point of coincidence in phase will move with the group-velocity of the group of waves, and actually in the limit propagates itself along an orbit obeying the laws of classical mechanics. In this limit orbits and point electrons again have a meaning.

Two constructs more different in conception than the matrix mechanics and the wave mechanics can scarcely be imagined, except that they are both generalisations of classical mechanics, retaining classical mechanics as a common limit. Schrödinger has suggested a physical analogy which perhaps shows their connexion. Suppose we have a stretched string of variable density. Then the wave mechanics finds the various ways in which the string can vibrate, and determines, *inter alia*, the nodes of the possible vibrations. These nodes are what we want, and the matrix mechanics is a calculus which determines them directly. It is perhaps not surprising that the ignoration of the rest of the string should lead to an unfamiliar procedure. Both schemes appear to make just those changes in the energy values of the stationary states which the facts were known to require. But the connexion between them is very deep and amounts almost, if not quite, to complete equivalence. To illustrate the connexion we must temporarily become technical. The change made in the wave mechanics is equivalent to deriving from the ordinary Hamiltonian equation of the system

$$H(q, p) - E = 0,$$

where (p, q) are canonical variables, the wave equation

$$\left[H\left(q, \frac{h}{2\pi i}\frac{\partial}{\partial q}\right) - E\right]\psi = 0 \quad . \; . \; . \; . \quad (2)$$

for the wave function ψ, instead of deriving the Hamilton-Jacobi equation

$$H\left(q, \frac{\partial S}{\partial q}\right) - E = 0$$

for the 'principal function' S. Equations (1) and (2) are different versions of the same equation. The p thus become differential operators. The close connexion between the operator algebra required in the wave mechanics and the matrix algebra of the matrix mechanics can be seen by a simple example. The commutative rule of the matrix mechanics already given becomes in the operator calculus, with $\frac{h}{2\pi i}\frac{\partial}{\partial q}$ for p,

$$\frac{\partial}{\partial q}(q\psi) - q\frac{\partial \psi}{\partial q} = \psi,$$

which is obviously satisfied. This example may perhaps remove the element of surprise at finding that Schrödinger has shown how to derive from the complete set of wave functions ψ_n for any atom a definite corresponding set of matrices which solve the problem of the same atom in the matrix mechanics. Whether the converse is true and the equivalence complete is less certain. At the moment it seems that matrix solutions may be possible which are not represented in the wave mechanics. The case in doubt is the rigid symmetrical top, for which in the matrix mechanics solutions appear to be possible both with whole and half quantum numbers, while only the former are allowable in the wave mechanics.[1]

It is probably futile at this stage to attempt to decide which of the new forms is the more fundamental. It will of course be found by the majority of workers that the wave mechanics, owing to the greater familiarity and convenience of its algebra, is the more powerful tool for solving any particular problem.

Let us now take a last glance at what the new mechanics in either form has done for us. In every case yet worked out completely, it has given us just exactly those changes of quantum numbers from the older theory, which had been forced on us already by the facts. Thus with the spinning electron the general theory of spectra is now an orderly whole. Weights, magnetic displacements, structure rules and intensity rules for multiplets and the complete form of the spectrum of the hydrogen atom are now at last correctly predicted by the theory. (It must be recorded that this requires us to assume that the spinning electron can be likened to a top with half quantum numbers. This assumption may require a trivial alteration of the wave mechanics in view of the wave-theory of the top.) But the wave mechanics has done more than this. It has already led us successfully to the attack of problems in which the results of the older theory could not be described as qualitatively correct. Such problems are, for example, the calculation of the exact values of the higher terms of the spectrum of neutral helium and the calculation of the terms of the positive molecular ion of hydrogen. Of the latter it is too early to speak with certainty. The successful calculation of the higher terms of ortho- and par-helium by Heisenberg marks outstanding progress. In the course of this work he has been led to study with success the phenomena of resonance between similar atoms or between the necessarily similar electrons in one atom. These phenomena promise to be of outstanding importance in the further development of the theory, and have already thrown much light on Pauli's important empiral principle that no two electrons in an atom can have the same quantum numbers, and on the problems of statistical mechanics. Nor is this all. A successful attack has at last been opened on the quantum theory of collisions and on non-periodic orbits, largely by Born and Oppenheimer.

However abstract the new mechanics may yet seem to us, however incomplete our grasp of its fundamental principles, it is impossible to overestimate its value to theoretical physics. We have, at least in the simpler problems, ceased to grope, and fudge our results until they are useable. We have at last a general dynamical method to apply to any atom, which is capable of yielding us by direct calculation any result for which we may ask. We cannot yet expect all such results to be right, but we are confident that only minor modifications and generalisations will be required.

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[1] For the matrix form, Dennison, *Phys. Rev.*, 28, 318 (1926); the wave form, Reiche, *Zeit. f. Phys.*, 39, 444 (1926). An interesting survey of wave mechanics is given by L. de Broglie, *J. de Phys. et le Radium*, 7, 321 (1926). I have not attempted to enumerate the primary references, which will be familiar to students of the quantum theory.

The Principles of Biological Control in Economic Entomology.[1]

By Dr. R. J. Tillyard, F.R.S., Chief of the Biological Department, Cawthron Institute, Nelson, N.Z.

II.

The Control of Injurious Weeds.

We turn now to the second problem, in which the introduced plant, not the insect, is the enemy of man. We have to decide the question whether it is advisable to undertake researches on the lines of introducing insects which will feed upon and tend to check the growth of those plants which, in new lands like Australia and New Zealand, have got beyond the control of man and threaten to swallow up large areas of valuable land.

I think the first point, undoubtedly, must be to insist that the method should only be used where a solution cannot be attained in any other direction. All are agreed that the unrestricted importation of plant-feeding insects into a new country is highly undesirable. The problem awaiting solution must be sufficiently grave in its nature to warrant the attempt being made with adequate safeguards, and under the guidance of the most competent experts obtainable.

We can turn again to the Hawaiian Islands for the pioneer experiments in this direction and learn very valuable lessons from them. The first attempt at biological control of a weed was that made in Hawaii on Lantana. This weed was attacked by the introduction of a considerable number of its natural insect enemies from Mexico. The result has been that it is prevented from seeding and has been successfully restrained from spreading all over the islands. Most fortunately for the experiment, none of the introduced insects has proved detrimental to crops or other cultivated plants, with the single exception of one species which occasionally does slight damage to the egg-plant or Aubergine. Considering the absence of the safeguards which I have elsewhere laid down as indispensable in these experiments, the result must be considered a lucky one rather than a strict precedent to follow.

Further experiments are now being carried out in Hawaii on the control of nut-grass by introduction of certain insect enemies from the Philippines, and also on the control of the Mexican weed 'Pamakani.' These are being carried out with good safeguards, and the results will be awaited with much interest.

I now come to the most remarkable attempt so far made in the direction of control of a noxious weed by insects, namely, the prickly pear campaign in Queensland and New South Wales. The prickly pear, *Opuntia inermis*, was introduced into eastern Australia long ago as a botanical curiosity, and was even propagated and distributed in pots to visiting squatter's wives. When these ladies tired of it as a pot plant it was thrown out. But instead of dying, as an ordinary plant would do, it proceeded to take root and multiply exceedingly. The luscious fruit were fed on by many species of birds, and the ripe seeds were carried far and wide in their droppings. This went on until about thirty million acres of land had been put out of cultivation by the pest, and the rate of increase was about one million acres per annum.

Then at last the long-suffering Australian populace raised its voice and demanded that something should be done. A Prickly Pear Board was set up, and the first attempts to control the pest were carried out along chemical lines, resulting in the discovery of certain poisonous gases which could be liberated over the infected areas, destroying the weed. This method, however, failed, as the cost of manufacture and application of the remedy proved far too high. Failure also resulted from all attempts to utilise the pest commercially; the water content was found to be exceptionally high, the quality of the fibre very poor, and the fodder value very low. Thus the vision arose of eastern Australia becoming in about a hundred years time a vast desert of prickly pear, with a few walled cities alone holding out against it. Then the demand for a remedy became so insistent that the natural prejudice against the introduction of insect enemies was at last overcome, and an organised attempt was made to deal with the pest in this manner. Prof. T. Harvey Johnston took charge of the work, which was later on further advanced under the charge of his original assistant, Mr. W. B. Alexander. These men travelled far and wide in the warmer parts of America to find insect enemies of the pest, and large consignments were shipped to Australia. They were then placed in special insectaries and tested out on all varieties of prickly pear and also on a large number of important economic plants.

It is interesting to note, as showing the high degree of specialisation attained by cactus-feeding insects, that not one of the many species introduced could be induced to feed on any other kind of plant; indeed, a number of the species would only eat a single variety of Opuntia and would not even change to a closely allied and botanically scarcely distinguishable species. A few larvæ, faced by the 'starvation test,' made slight attempts to eat unaccustomed plants, but the result in each case was severe indigestion followed by death.

The first Opuntia-feeding insect experimented with was the cochineal insect, *Dactylopius indicus*. It entirely destroyed some thousands of acres of one species of prickly pear, *Opuntia monacantha*, but was quite unable to feed upon the allied pest pear, *Opuntia inermis*. A search was therefore made for other species of Dactylopius, and finally *Dactylopius tomentosus* was found capable of attacking *O. inermis*. This little insect is now being distributed in enormous quantities through the infested districts, and is doing wonderful work in helping to destroy the pest. Though it does not do equally well in all districts and under all the varying conditions, yet it is now generally admitted that this species will prove one of the chief factors in the control of the pest.

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[1] Continued from p. 205.

Of many other species studied, the most promising appear to be the large coreid bug *Chelinidea tabulata*, the moth *Cactoblastis cactorum*, and perhaps the large longicorn beetles of the genus Moneilema. Large supplies of these insects are being reared in the insectaries, and it will be interesting to watch the progress of events when they are liberated.

It is of special importance to note that, in spite of the immensity of the insect fauna of eastern Australia, only one enemy has so far made its appearance in the field, namely, our old friend *Cryptolæmus montrouzieri*, the well-known enemy of mealy-bug. This lady-bird beetle has begun to attack *Dactylopius tomentosus*, but, so far, it has been found that the latter can more than hold its own, as it starts earlier and increases more quickly than its rival.

To sum up, it appears to be the general opinion in Australia that this formidable problem is in process of solution by means of the biological control gained by insect enemies over the pest.

This brings me logically to the consideration of the problems of weed-control which brought me to Europe. The most pressing of these for New Zealand, and to a considerable extent for Australia also, is the control of blackberry, *Rubus fruticosus*. The extent of the infestation in New Zealand may be judged by the saying current on the west coast of the South Island that they have only one blackberry bush, and that is 200 miles long. Certain areas in the North Island are almost as badly infested also. Not only does this terrible weed, originally introduced for its luscious fruit, spread vegetatively underground, so that each little plant soon grows into a great thicket, but the introduced European birds, especially the blackbird, feed ravenously on the fruit and so carry the seeds far and wide in their droppings. Nobody who has not seen this pest under the conditions prevailing in New Zealand to-day can really understand the menace that it offers to our civilisation. It seems simple to advocate 'closer settlement' and 'more careful cultivation' as the best methods of control; but when the extent and inaccessibility of the vast mountain fastnesses captured by the blackberry, from which with ever-increasing vigour it is spread far and wide over the richer lands, are realised, it will be understood that the hard-working men who are being driven off their farms after years of toil against this weed demand something more than this kind of advice.

The general insistence on something being done has led the Cawthron Institute to consider the taking up of this admittedly difficult problem on the lines of biological control. The chief difficulty is the central position occupied by the genus Rubus in the great natural order Rosaceæ, to which most of our finest economic plants belong. Thus the risk of damage to other valuable plants is appreciably higher than in the case of prickly pear or Lantana, and the safeguards imposed against the chance of such injury must be made correspondingly more severe. We will not even consider the introduction of any insect which is known to feed on plants other than Rubus, and we require very severe testing of these on a long series of native and introduced plants before we can consider their liberation.

Another bad weed which has taken possession of a very large area of ground in New Zealand and parts of Australia is gorse or furze, *Ulex europæus*. It is, however, a useful hedge plant, and, when young, provides good fodder for sheep; also, being leguminous, it improves the soil by the formation of nitrogen nodules. The problem of controlling gorse is therefore one of preventing it seeding, as it is the bursting of the seed-pods which is the main method of spread of this weed. This problem, I am glad to say, appears to have a fairly simple solution, for there are in England two or three insects which live wholly within the seed-pods of gorse and broom, and thus prevent them seeding without doing further injury to the plant.

Ragwort, *Senecio jacobæa*, is a poisonous plant which is becoming exceedingly abundant in New Zealand. When this plant is eaten by horses or cattle, cirrhosis of the liver results, ending in death, and no remedy is known for it. The control of ragwort by its insect enemies appears to be a feasible proposition, and is being undertaken by the Cawthron Institute at the present time.

St. John's wort, *Hypericum perforatum*, would scarcely appear likely to people in England to become a weed of importance. Yet it has so increased in size and vigour in parts of Victoria as to become a very serious menace, and the careful study of the possibility of controlling it by insects is one of the tasks which I have undertaken during my visit to England.

In conclusion, I would like to emphasise again the Imperial point of view in these researches. There are a large number of weeds introduced into various parts of the British Empire which we tolerate without having much idea of how far they rob us of the products of our labour. It has been calculated on a conservative basis that 10 per cent. of the world's crops are lost annually through the depredations of insects. I would like to ask whether anybody has attempted to make an estimate of what percentage of the Empire's crops are lost annually through the encroachments of noxious weeds? Think of the thirty million acres in Australia put entirely out of action by prickly pear, and the huge areas of cultivable land in New Zealand now 'going under' to blackberry and bracken-fern. Moreover, can we say that any weed, tolerated to-day as of no importance, may not in a few years time become a menace as great as the apparently harmless St. John's wort?

I declare emphatically that the menace is a most serious one in many parts of the Empire, and that we run the serious risk of being judged a race unfit to occupy these great areas, to the exclusion of other races, if we are going to allow them to 'go under' in the grip of introduced noxious weeds. The position demands the most careful consideration from those in responsible positions. Nothing less than an Empire-wide campaign will, in my opinion, suffice.

The Telephone.

In June last, Sir Oliver Lodge read a paper on the history and development of the telephone to the Institution of Electrical Engineers.[1] The occasion was the jubilee of the invention of the telephone by Graham Bell. The lecturer remembered Graham Bell speaking to the Physical Society of London in 1877. He was impressed by his clear and precise articulation. Graham Bell had devoted himself to the accurate production of human speech not only by his own lips and larynx but also by instrumental means. It is reported that he once said that it was fortunate that he was not a scientifically trained physicist; for if he had been, he would probably have thought that an articulating machine of a simple character was an impossibility. Talking machines had been invented before, but they were very complicated arrangements for producing vowel sounds. In this respect they were unlike the apparatus devised so successfully in our own day by Sir Richard Paget.

Graham Bell's machine took the sounds emanating from the human voice and sought to reproduce them at a distance by electrical methods. The way in which he found that this could be accomplished was surprisingly simple, and on Mar. 10, 1876, the first telephone worked successfully. Sir Oliver recalls how Kelvin showed two of Bell's early instruments at the British Association meeting in Glasgow, and how enthusiastic he was over the marvellous discovery. In these early days the same instrument could be used as a transmitter or a receiver. All the energy put into the circuit, therefore, came from the voice. Very soon, however, the Edison carbon and the Hughes microphone transmitter were invented, batteries were introduced, and the transmission was greatly improved.

When Clerk Maxwell first heard of the telephone, he pictured it in his mind as some instrument of marvellous ingenuity and constructive skill, as much excelling the siphon recorder as the recorder excelled an electric bell. When it first came over he has described his disappointment at its humble appearance, a disappointment only partly relieved by finding that it was able to talk. In this connexion Sir Richard Paget relates how, when Kelvin was staying with Lord Winchelsea, notice arrived that a talking machine, sent by Graham Bell, was coming. Lord Winchelsea dispatched a farm wagon to the station to collect it.

In 1888, Heaviside emphasised the similarity between Lodge's observations on electric waves in wires and Hertz's discovery of waves in free space. They both measured wave-lengths by reflecting them and converting them into stationary waves. Sparks were first used as detectors, but they were given up in 1890 in favour of the coherer principle, which was independently rediscovered and improved by Branly, who used iron filings and smeared metallic filings. This method was used in the earliest radio experiments. The discovery of the rectifying power of crystals and thermionic valves in the early years of the present century enormously improved the power to transmit speech and music, and improvements are still continually being made.

Wired and wireless telephony are constantly tending to approximate to one another. It is well known that by the use of accurate tuning and syntonised circuits it is possible to select from the multitude of disturbances in the ether only those of a given frequency. In practice, each sending station sends out carrier waves of definite wave-lengths, the voice modifying slightly the shape of these waves. This principle, so extensively used in broadcasting work, can be used for transmitting many telephone messages simultaneously by the same wire. Graham Bell also attempted to use this system in his harmonic telegraph.

In the transmitter and receiver we make use of Faraday's discovery—now nearly a century old—of the induction of currents by moving magnets. The transmitter may be regarded as a kind of dynamo and the receiver as a kind of motor. The transmission takes place by alternating currents flowing round the circuit. Owing to resistance, much of the electric energy is converted into heat. This leads to attenuation of the signals. The circuit also possesses capacity, and this Kelvin took theoretically into account. Heaviside next completed the practical theory by taking the inductance into account, and this led to the discovery of the distortionless circuit. Finally, Pupin persuaded American business men to construct 'loaded cables' and long-distance telephony was born.

Fleming's invention of the valve detector, further improved by Lee de Forest, has put into our hands an automatic relay of surpassing docility. Long-line transmission can be attained by a succession of short lengths of land line connected together by valve relays. The currents from the sending stations can now be sent great distances before they are relayed on with fresh energy. The American Telephone and Telegraph Company has in this way effected admirable speech transmission across the American continent.

In radio communication there is little attenuation and distortion. In free space there would be none. The theory of wave transmission in free space is extremely simple. It is only when matter is present that complications are introduced. It is true that there are many things which still seem mysterious to us, but there seems to be nothing that will ultimately be wholly unintelligible. We have bridged the Atlantic with radio telephony and can look forward to the time when sounds will veritably go out unto all lands and be heard by all who care to listen to them. "The progress of science is based upon faith in the ultimate intelligibility of everything: and so far wisdom has been justified of her children."

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[1] "The History and Development of the Telephone," *Jour. Inst. of Elect. Engrs.*, vol 64, p. 1098.

Obituary.

SIR ALFRED SEALE HASLAM.

BY the sudden death of Sir Alfred Haslam on Jan. 13 at the age of eighty-three years, Great Britain loses one of its principal pioneers in the development of the practice of refrigeration. More than any country, Great Britain depends on its overseas food supply, and the maintenance of that supply is only possible to-day through the application of artificial cold. Sir Alfred Haslam was one of the first British engineers to manufacture refrigerating machines, and the success of his work was recognised so long ago as 1888, when he received the freedom of the City of London for "services rendered to commerce."

The production of cold by artificial means can be traced back to Cullen and Leslie, and an important step was taken by Dr. Gorrie of New Orleans, who about 1845 caused compressed and cooled air to expand, working a piston in a cylinder. Other experimenters about that time used either ether or sulphur dioxide; but little progress was made until the mechanical theory of heat had been developed. The earliest attempt to preserve a cargo of meat by ice was made in 1860, but proved a failure. In 1876 the French worker Charles Tellier directed the fitting-out of the *Le Frigorique* with refrigerating apparatus for running between France and Buenos Ayres. Other workers in the field were Linde, John and Henry Bell, and James Coleman, who in 1877 produced a cold-air machine and with this brought home a cargo of meat from Australia.

It was about this time Sir Alfred Haslam took up the matter, and his great improvement was the invention of a dryer through which the air passed after compression and cooling, but prior to expansion. This successfully solved the problem of the prevention of the formation of snow. He bought up the Bell-Coleman patents, and one of the first Haslam machines was fitted in the R.M.S. *Orient* in 1881. By 1889 some 350 Haslam machines were at work ashore or afloat. In the development of the carbon dioxide and ammonia machines he also took a leading part. There are many types of refrigerators now in use, but the growth of the cold-storage industry has been remarkable, while in 1925 no fewer than 340 ships with a total insulated space of 70,000,000 cubic feet possessed Lloyds' refrigerating machinery certificate. Refrigerating machinery is also used largely in warships for maintaining explosives at a moderate temperature.

Sir Alfred Haslam came of a family long connected with the iron trade of Derby, and the Haslam Engineering Works there grew out of a small iron works belonging to his father. His knighthood was bestowed upon him in 1891 when Queen Victoria visited Derby.

DR. L. P. MANOUVRIER.

IN the *Times* of Jan. 20 appeared a brief announcement of the death of Dr. Leonce Pierre Manouvrier, of Paris, at the age of seventy-seven years. This is a loss to French anthropology which, notwithstanding his advanced age, will be deeply deplored. Manouvrier was Director of the laboratory at the Collège de France of the School of Advanced Studies (Anthropology) and professor of the School of Anthropology. He was secretary-general of the Society of Anthropology of Paris, which he joined in 1889, following Ch. Letourneau as secretary on the death of the latter in 1902. Latterly, Prof. Anthony has been associated with him as *Secrétaire adjoint*. Although Manouvrier never attained the commanding position of his great predecessors in office at the Society—Broca and Topinard—he had long been regarded as one of the foremost of French anthropologists. As a teacher of the School he was pre-eminent. His published work was characterised by its accurate and minute attention to detail, as was shown particularly in his many contributions to the *Bulletin* of the Society of Anthropology. He rarely failed to take part in the meetings of the Society, and his contributions to the discussions were marked by clarity and precision. He was an honorary fellow of the Royal Anthropological Institute of Great Britain, and an honorary or corresponding member of most of the important anthropological societies on the Continent.

BY the death of Frederick Gordon Pearcey at Newport, Mon., on Jan. 26, at the age of seventy years, there passed away the last survivor of the scientific staff of the *Challenger* Expedition. Mr. Pearcey was attached to the biological laboratory of the *Challenger* in 1872 as taxidermist and general assistant, and on the completion of the voyage he assisted Sir Wyville Thomson and Sir John Murray in the *Challenger* Office at Edinburgh, acquiring great skill in identifying species, especially of Foraminifera, on which he wrote several papers. He devised methods for cutting microscopical sections of marine deposits, and became proficient in all branches of practical oceanography and museum arrangement. His alert intelligence and obliging disposition made him a favourite with all contributors to the *Challenger* memoirs. When the last of the *Reports* was published he worked for a time at the Marine Biological Station at Granton and at Millport on the Clyde. In 1889 he went to the Owens College Museum in Manchester. Nine years later he joined the staff of the Scottish Fishery Board, but in 1905 he returned to museum work, going to the Bristol Museum as assistant curator of zoology; there he remained until his retirement after the breakdown of his health last year.

WE regret to announce the following deaths:

Mr. J. J. Lister, F.R.S., distinguished for his work on the Foraminifera and author of the article on Mycetozoa in the eleventh edition of the "Encyclopædia Britannica," on Feb. 5, aged sixty-nine years.

Prof. Thorkild Rovsing, professor of clinical surgery and sometime Rector Magnificus of the University of Copenhagen, on Jan. 13, aged sixty-two years.

News and Views.

The retirement on Mar. 9, under the age clause, of Sir Sidney Harmer from the directorship of the Natural History Museum, South Kensington, will remove from active professional life one who has been for forty years conspicuous for his researches in zoology and influence upon this branch of science. Fellow of University College, London (1884), and later fellow, lecturer, and tutor of King's College, Cambridge, he made the latter his home until in 1908 he came to London as keeper in zoology at the Natural History Museum, afterwards becoming director in 1919. Trained under F. M. Balfour, his first researches were directed to the elucidation of the anatomy, embryology, and position of the Polyzoa; later, his interest shifted to the natural history, evolution, and classification of the group. With Sir Arthur Shipley he edited the "Cambridge Natural History," 1896–1909, which owing to his painstaking care is recognised as giving a complete epitome of the facts of zoology at the dates of publication. He was president of Section D of the British Association in 1908, choosing the Polyzoa as his subject—suggesting that there may be segregation in the formation of a bud analogous to the segregation of characters in the formation of gametes. In recent years his interest turned to the whales, and this was the underlying force in sending out the *Discovery* expedition to South Georgia to investigate these forms. It says much for his enthusiasm and determination that he induced the British Government, in a time of great financial stress, to send out this the greatest British expedition since the *Challenger*, the results of which will be the monument to him as director of the Natural History Museum.

Sir Sidney Harmer's directorship has not been marked by any great changes in the main fabric of the exhibition building or in the arrangements of the exhibits of the Natural History Museum. A new wing to the Museum was projected and actually agreed to before the War, but this has never been proceeded with. It is true that a new spirit building has been erected, and most of the staff dealing with water-living animals has removed there. The space thus vacated in the basement was assigned to entomology; space intended solely for store purposes, but used also as research rooms by the staff. It is not too much to say that the congestion here is appalling, especially as housing has had to be found for the Imperial Bureau of Entomology. The best results, too, are not to be obtained by setting sedentary workers in relatively dark basements. Of new material, the large collection of deposits of the late Sir John Murray is housed in a temporary building in the grounds, and the exhibition of the Cetacea cannot be deemed satisfactory. The present condition of the Natural History Museum reflects the highest credit on the members of the whole staff, but there is no possibility of overlooking the fact that progress on all sides is being seriously impeded by the lack of storage and working space. If storage space is provided. it will be possible so to rearrange and reduce the exhibits as the better to expose their beauty and scientific importance, thus adding to the attractiveness of the Museum to the public.

The Commonwealth Council for Scientific and Industrial Research held its second session last November and made a number of important decisions regarding future policy. Prof. A. C. D. Rivett, a member of the executive committee, will devote his full time to the work of the Council during 1927, as its chief executive officer, having been granted leave of absence for this purpose by the University of Melbourne. Mr. Gerald Lightfoot is to be secretary to the Council. In connexion with work on fruit storage and transport, Dr. Kidd, of the Cambridge Low Temperature Research Station, will visit Australia during the first half of this year in order to survey the position and suggest a comprehensive scheme of work. Dr. W. J. Young, associate professor of biochemistry at Melbourne, will meet Dr. Kidd at Cape Town and with him study existing practice there before proceeding with the investigation of Australian conditions. It is hoped that Dr. Young will take charge permanently of later developments in Australia. Prof. T. Brailsford Robertson, of the University of Adelaide, has been invited to take the position of officer in charge of investigations into problems of the nutrition of stock. He will probably continue his present fundamental researches at Adelaide while organising and developing national investigations prompted by the needs of the wool, meat, and dairying industries.

Inquiries are being made throughout the British Empire by the Commonwealth Council for an entomologist and a mycologist to initiate and steadily develop organisations for research work upon the numerous insect and fungus pests that annually levy great toll on primary industry. A considerable scheme for attacking the diverse problems of the irrigation settlements in the Murray and Murrumbidgee river areas is being put into operation with the hearty co-operation of the departments of the State Governments concerned. Prof. Prescott, of the Waite Agricultural Research Institute, is to be asked to supervise and co-ordinate all soil survey work. The solution of certain problems in these irrigation areas is of importance in relation to possible increased settlement by migration from Britain. Forestry matters are also receiving attention, and it is expected that a prominent officer from the Indian Forestry Service will visit Australia early this year to report upon the establishment of a forest products research laboratory.

In these and other actions the Commonwealth Council is following the definite plan of seeking competent full-time officers to take charge of a number of departments of investigation. Committees will no doubt be formed to assist so far as possible in the work, but the system of relying on such committees to supervise extensive researches, the details of which are carried out by officers acting under their instructions, has been abandoned. It is hoped that the Council will very soon possess a highly trained senior staff and be able to proceed with intensive study of the seemingly innumerable problems which beset Australian industries. For the time being, attention will be directed mainly to primary industries, though decisions to proceed with radio research work and with the provision and maintenance of ultimate physical standards, in close co-operation with the physics departments of the universities and the Defence Department, indicate that advance in other directions will not be long delayed. Throughout its programme the Council aims at the closest possible association with the Department of Scientific and Industrial Research in London, from the officers of which it is receiving very valuable assistance and advice.

The Friday evening discourse on Feb. 4 at the Royal Institution was delivered by Sir Arthur Keith, on "Human Races, Old and New." Five well-marked types or stocks are recognised among the living representatives of mankind: the white or Caucasian type, the Mongolian peoples—between them making up fully seven-tenths of the total population of the world—the black or Negro type, the brown or Dravidian race south of the Himalayas, and the Australoid. However numerous or extensive human migrations may have been in long-past times, they have left the great breeding grounds of the primary races of mankind untouched. How are we to account for the fact that each part of the world is populated by a distinctive breed of mankind? There is only one theory which offers an explanation, and that is the one put forward by Darwin. He held that the most favourable sites for the evolution of new forms were the centres of wide continental spaces. All that we know of the past and present distribution of human races favours this theory. If we accept such an explanation we must regard the Negro, the Chinaman, and the European as the most recent expression of their respective types. Each we may regard as the type of being best adapted for the country and culture in which it has been evolved. On each side of the racial frontiers of the world we find intermediate types.

There has been, beyond any doubt, much intermarriage and intermingling across racial frontiers, but such an explanation, although accepted by the majority of anthropologists, does not, in Sir Arthur Keith's opinion, account for the gradual transition which we usually find in passing from the centre of one racial area to the centre of another. Those who seek to explain the existence of intermediate types by interbreeding of primary forms forget that the first duty of an anthropologist is to account for the primary forms—the Nord, the Negro, the Mongol, or the Caucasian. If evolution is true, and Negro and Caucasian are the descendants of a common ancestor, then we ought to find, just as we do find, a series of intermediate types joining the centres where the new types have been cradled; the extreme and most fully differentiated types represent the older and less-changed forms. Politicians and anthropologists differ altogether in their conceptions as to what constitutes a separate race. The politician concentrates his attention on tradition, language, and spirit; a race, to claim the title in an anthropological sense, must have characteristics which mark it off from all other peoples. In this sense the races of western Europe are very imperfectly separable—not because of the interminglings which have occurred, but because they are branches of the same stock, and time and space have been insufficient to permit more than a partial differentiation.

On Tuesday, Feb. 1, the second lecture of the series being given at Bedford College for Women, London, was delivered by Sir Thomas Heath, who dealt with "Conceptions of the Cosmos in the Classical Period." Sir Thomas reviewed in detail the speculations of the early Greek philosophers. Thales showed little advance upon the popular cosmology derived from Egypt and Babylon; but original thought began with Anaximander (early sixth century B.C.), who held that the earth was a cylinder suspended in equilibrium in the centre of the universe, and explained the light of the heavenly bodies by hollow rings or hoops encircling it, containing fire visible only at one point. He said there were other worlds than ours, and also propounded a primitive theory of evolution. Anaxagoras strikingly anticipated Laplace when he traced the origin of the cosmos to a rotatory movement imposed by mind upon primal chaos and postulated centrifugal as well as centripetal force. While the geocentric conception tended to prevail, and was adopted both by Plato and by Aristotle (who worked out, under the influence of Eudoxus, an elaborate system of concentric spheres to explain the movements of the heavenly bodies), the Copernican theory was anticipated partly by the later Pythagoreans and by Heraclides of Pontus, and wholly by Aristarchus of Samos, who said that the earth revolves round the sun, while the sun and the fixed stars (whose sphere is of immense size) are unmoved. The method of Tycho Brahe was anticipated by Appolonius of Samos in his attempts to explain the movements of the planets. On the physical side, the atomic theory propounded by Leucippus and Democritus and adopted by the Epicureans was remarkably in accord with modern thought. Sir Thomas gave a masterly exposition of much of the detailed astronomical and mathematical work of these early thinkers, whose conclusions, often sounder than their methods, illustrate the saying of Aristotle that "not once nor twice, but times without number, the same thoughts occur to men."

On Feb. 1 the University of Oxford was presented with the most valuable property that it has ever received. The Radcliffe Library, the great dome of which figures so prominently in the best-known of Oxford views; the freehold of the adjacent land on which it stands; the books in the Science Library at the University Museum, and an income of £1500 a year for the upkeep of that Library, were all conveyed by the Radcliffe Trustees as a gift and were gratefully accepted. The Radcliffe Library is a scientific institution of international importance, and so its future government, on which so much depends, is a matter for grave deliberation. Its success hitherto has been due to the strict observance of the Radcliffe Trust as defined by Dr. Radcliffe in his will, namely, the appointment of a librarian. For some unpublished reason neither the Trustees nor the Radcliffe electors have done anything to carry out their duty in this respect during the past three years that have elapsed since the death of the last eminent holder of the office, Dr. Jackson. During these three years the Library has lost many books by theft, the scientific world has been deprived of one of its most useful officials, and the Radcliffe Trust has not been carried out.

The reason sometimes suggested for the inactivity of the Radcliffe Trustees is that this unique and admirably arranged scientific Library is to be reduced to the condition of an appanage of the Bodleian, a library that is primarily managed in the interests of literary and classical scholars, and the lack of accessibility of its books makes it unsuited to the every-day needs of the student of science. Moreover, scientific literature in the Bodleian is rarely quite up to date; a recent visit disclosed the fact that the 'current' number of Nature was nearly two months old. Many have found it impossible to do scientific work in so lethargic an atmosphere, and all who are well acquainted with the condition obtaining in the two libraries fear that the substitution of Bodleian control for control by an independent scientific Radcliffe librarian will be a disaster rather than a gain to the cause both of academic and of international learning.

The University of Oxford has every reason to be grateful to the generosity of the Evans family. During and after his keepership of the Ashmolean Museum (1884–1908) Sir A. J. Evans presented his Cretan collections as well as the magnificent series of Anglo-Saxon and Teutonic ornaments collected by his father, Sir John Evans, that have gone so far to elucidate the early history of Ægean and North European culture. His brother, Dr. Lewis Evans, has given those splendid examples of early scientific instruments which are now one of the established sights of Oxford in the Old Ashmolean Building, where they form the nucleus of a museum for illustrating the history of science. Now Sir Arthur has presented yet another of his father's collections, in illustration of the palæolithic, neolithic, bronze, and early iron ages not only in Britain but also in many parts of central, southern, and northern Europe, including a fine series of ancient British gold ornaments and of objects from the well-known cemetery of Hallstadt. A large number of the specimens have been figured in the classical works of Sir John Evans on the stone age, and with these are coming a number of Romano-British relics and some Egyptian antiquities of great variety. It is not easy to draw the line between civilisation and barbarism, but the united gifts of the Evans family now cover both sides of the line, and in a manner which can never be accomplished again.

The Italian Government has voted the sum of two million lire for the purpose of resuming the excavation of Herculaneum according to the plan drawn up by Prof. Majuri of Naples and approved by Signor Mussolini and the Minister of Public Instruction. This sum will cover the initial expenses of beginning excavation in the coming spring, and further sums, it is said, will be forthcoming year by year as the work proceeds. The greatest obstacle in pursuing the excavation hitherto has been the fear that the villages of Resina and Portici, which overlie the site, would have to be expropriated and the inhabitants evicted. According to a well-informed writer in the *Italian Mail* of Jan. 29, this step is not now considered necessary. Excavations will be carried on at the south-east of the ruins at a point midway between Resina and Torre del Greco, use being made of the shafts left by former excavators to penetrate the city. As much as possible will be laid open, but those parts which cannot be opened up will be lit by electric light. Both what is known of the status of the inhabitants of Herculaneum at the time of its destruction, and previous finds of objects of art and manuscripts, make it difficult to overestimate the additions to our knowledge of Italian life and culture at the beginning of our era, and of classical literature which may follow, should the Italian Government carry out the excavations on the scale projected.

Preparations are now being made for an expedition of anthropological investigation among the tribes of the south Abyssinian frontier. The expedition is to be conducted by Mr. J. H. P. Driberg, the author of a valuable book on the Lango, and formerly an official in East Africa, who will go out under the auspices of the Royal Anthropological Institute. If the arrangements are sufficiently far advanced and the funds received towards the expenses justify, the expedition will leave England some time during the month of April. The object of the expedition will be to investigate the physical anthropology and social organisation of the Pagan Galla of southern Abyssinia, and of various nomad tribes in Abyssinia and Kenya. Tribes on the north-eastern frontier of Uganda and the south-eastern Sudan will be on the way to Abyssinia, and it is hoped that it may be possible to get into touch with the Turkana of Kenya, a very important group of people which is but little known. In addition to the ethnological investigations, zoological observations will be made and economic plants, as well as plants and drugs used by the natives for magical purposes, will be collected. Mr. Driberg will be accompanied by Dr. J. O. Beaven, who will be responsible for physical anthropology, pathology, and zoology as well as the bulk of the photographic work. If funds allow, the expedition will last for three years, about eighteen months of which will be spent in a preliminary investigation of the smaller tribes before going on to the main objective, the Galla.

The expedition has the support of the Royal Society and the British Association for the Advancement of Science, both of which bodies have made grants towards the expenses.

Mr. Gordon Hume, in *Discovery* for February, directs attention to an anomalous conclusion, drawn from the results of an inspection of strata and their contents on an excavated site in King Street, Cheapside, which would appear to suggest caution in the chronological interpretation of archæological evidence in the City of London area. In a section measuring 4ft. 3 in. in depth were revealed eight archæological levels—seven well-marked, the eighth confused—between virgin soil (18 ft. below street level) and an upper stratum consisting of a series of deposits superimposed closely one upon another. Samian ware was found in varying frequency in levels 1, 2, 6, 7, and 8—in the last named merely a tiny fragment. The eight layers, on the usual reckoning for the city of London of one foot per century, would represent at least four hundred years; yet, as stated, throughout the series there occurs Samian ware which is usually attributed to the period A.D. 1 to 110, and no specimen of post-Trajanic pottery was found. It would therefore seem either that material accumulated on this site at a rate unheard of in the rest of London—it shows no signs of exceptional circumstances such as the existence of a rubbish heap—or else that, if the four feet of deposit does really represent four centuries, Samian pottery of the first-century type was used and manufactured in London so late as the fifth century. As all the London Samian ware belongs to the type of that of the King Street site, Mr. Hume finds himself left with the dilemma that either the accepted scheme of dating of Dragendorff and Déchelette requires reconsideration or that the rate of accumulation of soil in London represents problems yet to be solved.

The subject of Prof. Eddington's third Gifford Lecture in the University of Edinburgh on Friday, Feb. 4, was "The Running-down of the World." It began with a consideration of the random element in the world, the study of which rests on the law of chance, a law on which the physicist, perhaps, places greater trust than on any other accepted law of Nature. The scientific measure of that random element in the world is called entropy. From the point of view of the philosophy of science, Prof. Eddington thinks that entropy must be ranked as the great contribution of the nineteenth century to scientific thought. It made a reaction from the view that all that is essential can be found by applying a microscope to the world. While Einstein's theory of spherical space has removed all difficulty as to the infinity of space, we are still confronted with the dilemma of an infinity of time, especially the difficulty of an infinite past. But between us and the infinite past lies a more pressing difficulty, namely, the winding-up of the universe. The organisation of the energy of the world is being continually reduced by the continual increase of the random element; in the past we must attribute a greater and greater degree of organisation, and it is impossible to follow such an increase back indefinitely.

While deprecating any hasty inference that this involves the interference of a creator of organisation at a not infinitely-remote time in the past, Prof. Eddington thinks we must recognise that current physics rests on the view that there is in the world not only chance but also the antithesis of chance. We may not be justified in relating this 'antichance' at all closely to that which appears to our consciousness in the guise of purpose and design. Chance requires its complement 'antichance' as much as positive electricity requires its complement negative electricity, and physics should not be regarded as wedded to one rather than to the other. The 'fortuitous concourse of atoms' which has been so much of a bugbear is now definitely limited in physics to a well-recognised type of system, namely, a system in thermodynamical equilibrium; physicists, however, would be the first to protest against the idea that that condition is typical of the world in general.

Further details of the information acquired by the Dutch-American Expedition to New Guinea during its stay among the pygmies of the Nassau Mountains have been issued by the Smithsonian Institution of Washington. Dr. Stirling, the leader of the expedition, states that the pygmies are mild-mannered, quiet, and unobtrusive, and not in the least nervous. They are energetic agriculturists and entirely vegetarian, cultivating sweet potato, sugar-cane, taro, raspberries, tobacco, and a number of other plants not recognised. They raise pigs in considerable numbers and have dogs. Various implements of stone are in use—axes, knives, hoes, wedges, and so on. They have no knowledge of iron. Their principal weapon is the bow and arrow. In an interview with a representative of the *Times* at Port Said which appeared in the issue of that paper of Feb. 2, Dr. Stirling gave a further account of the culture of the negritos, in the course of which he referred to their use of tobacco in pipes and in cigarettes, and their trade by means of barter or with cowries as their medium of exchange. Each village is administered by a headman and elders, but there are no chiefs. Before marriage the bridegroom has to undergo an ordeal in which arrows are shot at him, and when a wife is divorced the top joint of the index finger is cut off; the same mutilation is performed on the other fingers for succeeding divorces. Polygamy is practised. Their religion is animistic, and they have a great faith in the virtue of amulets The average height of the pygmies is said to be 4 ft. 2 in. and their colour quite black.

On Dec. 27 last, Prof. M. Pupin, the retiring president of the American Association for the Advancement of Science, gave an address on "Fifty Years' Progress in Electrical Communications." He lays stress on the important part played by Maxwell's electromagnetic theory in the development of telegraphic and telephonic science. He also points out how invaluable thermionic tubes are in everyday work. Perhaps undue importance is attached to those who gave the first experimental demonstrations of the new methods. For example, in 1853 William Thomson proved theoretically that in certain cases the discharge of a Leyden jar is oscillatory, and Feddersen deserves great credit for verifying this experimentally six years later. But Thomson's formulæ are still quoted in every treatise on radio communication. Heaviside describes clearly how the variables of his distortionless circuit are connected, and if the adjustment is not perfect we can easily see how it can be improved by varying any one of the four variables. A knowledge of what Maxwell has done does not help us to do this. One interesting point Pupin mentions is that, since Faraday, every great advancement in the art of electrical communication has originated in the research laboratories of the universities, and not in the test-rooms or research laboratories of manufacturing companies. He points out that the natural electrical disturbances which take place in electrical circuits, such as static disturbances, fading, earth currents in cables, etc., deserve close study, as they may enable us to find the secrets of the natural processes going on in the sun, the central power-station which supplies the moving power to all our organic and human activities.

An account issued to the Press by the New York Electrical Society of an address on fused quartz given by Dr. Berry, of the American General Electric Co., would be singularly misleading to any one not familiar with the subject. We read that fused quartz is a "new and remarkable material" which by its property of inexpansibility "opens new scientific advances in fields as distinct from each other as astronomy and fire prevention." From this one might be led to conclude that fused quartz is an American discovery of recent date; and so with each application of the material to science and industry—the material being newly discovered, its applications must also be new. The application of fused quartz to fire-sprinkler bulbs, and again the suggestion of its use to replace glass in astronomical instruments and the like, scarcely merit the designation of "new scientific advances." Sprinkler bulbs of fused quartz were made commercially in England so long ago as 1912—and there seems little novelty in the suggested application of quartz to the second purpose mentioned, although the successful manufacture of blocks 8 ft. to 10 ft. diameter would certainly be an advance.

One of the activating motives of the work on fused quartz done in England in the last twenty odd years, has been the commercial production of really large pieces of transparent fused quartz (such as discs 2 ft. and upwards in diameter)—as yet such pieces are not available. The paper mentioned above suggests that sizeable 'blocks' of transparent quartz are available in America for astronomical purposes. This reference, occurring as it does in a paragraph immediately following reference to glass "blocks 8-10 ft. diameter," would make clearer reading if the actual size of the fused quartz 'blocks' were specified. No novelty attaches to the suggestion to use fused quartz for astronomical purposes. An actual installation will, however, be a matter worthy of adulatory comment. Reading further, we find that Dr. Berry 'discloses' the use of fused quartz in experimental biological studies of the effects of ultra-violet radiation; what recent obscurity there has been about such a use must have been purely local. It is not to be doubted that the American scientific worker is as an individual anxious to acknowledge prior discovery and development in a field of activity which he may enter. It is unfortunate, therefore, that a statement issued by a well-known American society should be so misleading, and we are forced to the conclusion that there must have been in this case a singular lack of knowledge of the facts.

The botanical library of Capt. John Donnell Smith of Baltimore, consisting of some 1600 carefully selected and beautifully bound volumes, with his plant collection of more than 100,000 specimens, which was presented to the Smithsonian Institution of Washington twenty-two years ago, has only now been deposited there, and constitutes the most valuable botanical gift ever made to the Institution. The library includes some valuable and very rare volumes, and is particularly rich in works descriptive of tropical American plants, especially those of Central America. At the time of presentation to the Smithsonian, Capt. Smith's herbarium was the finest in existence for Central America, and is of great scientific interest because it includes so many type forms. Besides American species, the collection includes sets of plants from all over the face of the globe, China, Tibet, Central Asia, India, Australia, Africa, and has already been the basis of much important work by the Smithsonian botanists. The results of the labours of one of America's most enthusiastic and indefatigable botanists thus become available for general reference.

The January number of the *Empire Cotton Growing Review* (vol. 4, No. 1) is the first to be issued by the new publishers, Messrs. P. S. King and Son, Ltd., 14 Great Smith Street, London, S.W.1. The journal is the organ of the Empire Cotton Growing Corporation, and the work and aims of that organisation should be more widely known than they are at present. Any attempt to further the economic independence of the Empire is worthy of support; and it is the endeavour of the Corporation to extend the cultivation of cotton within the British Empire, for "an increase in the number of sources of raw cotton is a matter of the most urgent importance." With this end in view, the services of skilled plant physiologists, pathologists, geneticists, economists, and others have been concentrated on improving and extending the cotton yield, and the results of the researches of those specialists are published in the Corporation's journal. The present issue contains some interesting and useful articles, and preserves an even balance between the scientific and economic aspects of the problem. For those engaged in any branch of the cotton industry the "Notes on Current Literature" at the end will be found invaluable.

The Rockefeller Foundation has issued a fifth series of "Methods and Problems of Medical Education." Descriptions are given of the Departments of Anatomy, Pathology, Bacteriology and Public Health, and Physiology of the Washington University School of Medicine, St. Louis, Mo.; of the Departments of Physiology, Botany, Anatomy, Zoology, Biochemistry, and Pharmacology of McGill University, Montreal; of the Institute of Pathology of the University of Utrecht, and others. The descriptions are by the heads of the Departments, are copiously illustrated and show plans of the buildings, while details of finance and research are also given. "Le Service de Prophylaxie Mentale du Département de la Seine, Paris," and the "Centre Régional de Toulouse pour la lutte contre le Cancer" are also described. Dr. Bela Schick gives the method of charting clinical records of children's diseases adopted at Mt. Sinai Hospital, New York, and Profs. Estor and Pech, of Montpellier, describe an apparatus for viewing an operation at a distance from the surgeon, or even in an adjoining room. It consists of two large mirrors, one above the other; the upper mirror receives the image of the operation and reflects it down into the lower mirror in which it is viewed, a special illuminating lamp being employed.

The first congress of the International Association of Soil Science will convene on June 13 in Washington, D.C. The congress will be followed by a field excursion to visit the various important soil belts in the United States. Opportunity will also be given to the delegates to acquaint themselves with various agricultural industries, some of the leading agricultural experiment stations and, in general, with the agricultural resources of the country. The association is made up of six international commissions, each acting under an independent chairman, and the programmes of the commissions are now in course of preparation. Each will consist of papers presented by invitation by outstanding investigators in the respective fields, and of papers presented by various workers in the different branches of soil science, by members or non-members of the association. Titles of the papers to be presented and brief abstracts in English, French, and German should be sent to Dr. J. G. Lipman, New Brunswick, New Jersey, U.S.A. The congress will bring together workers interested in the different problems of soil classification, soil analysis, fertilisation and treatment, as well as the relation of the soil to plant growth. Extensive exhibits of various soil types, of apparatus used in soil analysis, and of the soil microflora and microfauna will be held during the congress.

Sir Ernest Rutherford will deliver the twelfth Guthrie lecture to the Physical Society of London on Friday, Feb. 25, taking as his subject "Atomic Nuclei and their Transformations."

With the view of encouraging original research in sanitary science, scholarships of the yearly value of £300, plus an allowance for apparatus, etc., are being offered by the Grocers' Company. The scholarships will be tenable for one year, but renewable for a second or third year. Applications must be made before the end of April to the Clerk of the Grocers' Company, Grocers' Hall, E.C.2, upon a form obtainable upon request.

The Edison Medal of the American Institute of Electrical Engineers for 1926 has been awarded to Dr. William David Coolidge, the assistant director of the research laboratory of the General Electric Company, for the production of ductile tungsten and the fundamental improvement of the X-ray tube. Dr. Coolidge, who is an honorary member of the Röntgen Society, was born in Hudson, Massachusetts, on Oct. 23, 1873, and is a graduate of the Massachusetts Institute of Technology and a Ph.D. of Leipzig. After some years as a teacher of physical chemistry at Massachusetts he became associated with the General Electric Company in 1905, and was made assistant-director of research three years later.

Prof. J. Brontë Gatenby, Zoological Department, Trinity College, Dublin, informs us that, in conjunction with Dr. E. V. Cowdry, of the Rockefeller Institute, N.Y., he is editing a new edition—the ninth—of Lee's "Microtomist's Vademecum." He invites research workers and others to forward to him, as soon as possible, any new information suitable for incorporation in the forthcoming edition. It is not proposed to include bacteriological technique.

The seventieth birthday of Prof. D. A. Low, of East London College, was celebrated on Feb. 9 by a dinner arranged by his old students. Prof. Low came from Dundee, and after serving his apprenticeship as an engineer, studied at Owen's College, Manchester, and at the University of Glasgow. In 1887 he was appointed headmaster of the Day Technical School for boys at the People's Palace, London, and on the formation of East London College he was made professor of engineering, a post which he held for twenty-six years. During this time he served on the Faculty of Engineering of the University of London, later becoming secretary, and on his retirement he was made emeritus professor. Prof. Low is the author of many textbooks on machine drawing and allied subjects.

At the general committee which closed the fourteenth annual meeting of the Indian Science Congress held at Lahore during the week Jan. 3-8, the president, Sir J. C. Bose, announced that since meeting in Bombay the past presidents had associated themselves in a presentation to Dr. J. L. Simonsen on his retirement from the office of honorary general secretary. In taking this action the past presidents were confident of thus giving tangible form to the feeling among members of the Congress, that the development of scientific thought and practice in India will remain heavily indebted to Dr. Simonsen, who has not only served as honorary general secretary during thirteen years, but to whose activity and enthusiasm in its early stages the foundation and survival of the Congress are substantially due. The general committee approved this action of the past presidents, and unanimously elected Dr. Simonsen president of the fifteenth annual meeting of the Indian Science Congress to be held in Calcutta during the week Jan. 2-7, 1928.

A new and cheaper impression of Prof. A. N. Whitehead's "Science and the Modern World" is to be published almost at once by the Cambridge University Press, and at a later date a new impression of the same author's "Religion in the Making." The same house also promises a new book by Dr. C. Davison entitled "Founders of Seismology," being in effect a history of the study of earthquakes ranged round the founders of the science from John Bevis and Elie Bertrand down to Prof. John Milne and Prof. Fusakichi Omori.

Applications are invited for the following appointments, on or before the dates mentioned:—A full-time assistant lecturer in pharmaceutics at the Cardiff Technical College—The Principal, The Technical College, Cardiff (Feb. 19). A keeper of the laboratories of the Royal Horticultural Society at Wisley—The Secretary, Royal Horticultural Society, Vincent Square, S.W.1 (Feb. 22). An assistant entomologist at the Rothamsted Experimental Station—The Secretary, Rothamsted Experimental Station, Harpenden (Feb. 26). A lecturer in the department of botany (special subject—plant physiology). King's College, London—The Secretary, King's College, Strand, W.C.2 (March 2). A professor of physiology in the University of Birmingham—The Secretary, The University, Birmingham (April 23). A head of the agricultural department and farm director of the Harper Adams Agricultural College, Newport, Salop—The Principal, Harper Adams Agricultural College, Newport, Salop. An assistant bacteriologist at the Wellcome Tropical Research Laboratories, Khartoum—The Director of the Laboratories. A head of the department of bakery and confectionery of the Borough Polytechnic Institute—The Principal, Borough Polytechnic Institute, Borough Road, S.E.1. A technical officer, grade II., at the Royal Aircraft Establishment, South Farnborough, for duties in the technical supervision of the application of all equipment used in aeroplanes built under contract for the Air Ministry—The Chief Superintendent, Royal Aircraft Establishment, South Farnborough, Hants (quoting A 127).

Our Astronomical Column.

Comets.—An orbit of comet 1927 *b* (Reid) has been telegraphed from South Africa, from which it appears to have passed perihelion in 1926, so it will presumably be numbered as 1926 VII. The orbit indicates that the motion in R.A. in the former telegram was erroneous; it was sent as +44 sec., but it should be about +11 min. The comet has begun to travel northward, and should be visible in Europe about the middle of March.

$$\begin{aligned} T &= 1926 \text{ Dec. } 30{\cdot}54 \text{ U.T.} \\ \omega &= 224^\circ\ 45' \\ \Omega &= 108\ \ 42 \\ i &= \ \ 83\ \ 40 \\ \log q &= 9{\cdot}87708 \end{aligned}$$

Annals of Moscow Observatory, Vol. 8, No. 1, contain definitive elements of comet 1904 I. (Brooks) by M. S. Kasakov.

$$\begin{aligned} T &= 1904 \text{ Mar. } 7{\cdot}138756 \text{ G.M.T.} \\ & \left.\begin{aligned} \omega &= \ \ 53^\circ\ 32'\ 34''{\cdot}0 \\ \Omega &= 275\ \ 47\ 25{\cdot}4 \\ i &= 125\ \ \ \ 7\ 42{\cdot}5 \end{aligned}\right\} 1904{\cdot}0 \\ e &= 1{\cdot}0013646 \\ \log q &= 0{\cdot}432643 \end{aligned}$$

As the comet was observed from April 16, 1904, until June 5, 1905 (besides a photograph on May 14, 1903, not used in the above orbit), the hyperbolic character is well established.

Mercury as an Evening Star.—Mercury will be well placed as an evening star in the second half of February, reaching elongation on Feb. 25, when it is 18° from the sun and 8½° north of it. The latter point is of importance for increasing its height above the horizon at sunset. Herr Carl Schoch, who is well known for his researches in ancient astronomy, contributes an article to the *Stegliter Anzeiger* of Jan. 20 in which he points out the assiduity with which Mercury was observed in Babylon, and the importance of the *arcus visionis*, or length of time of visibility of the planet. On Feb. 22 it will set $1^h\ 40^m$ after the sun, and should be visible to the naked eye for nearly half an hour. This is the best evening elongation of the present year. The presence of Venus some 5° further east will add to the interest.

Herr Schoch asks naked-eye observers to send him notes of the duration of visibility of Mercury, that he may compare them with the Babylonian records.

Photographs of Mars in 1926.—An extensive series of photographs of Mars during September and October of last year was made by Mr. F. E. Ross at the Mount Wilson and Lick observatories. A preliminary account of the results obtained are given by him in the *Astrophysical Journal*, vol. 64, p. 243. A special enlarging camera was used, attached to the 60-inch telescope at Mount Wilson, and photographs were taken in light of five different colours (ultra-violet, blue, yellow, red, and infra-red) with the aid of suitable filters. At the Lick Observatory the camera was attached to the 36-inch refractor, the photographs being taken only in yellow and infra-red light. The photographs discussed in this preliminary paper are extremely interesting in showing that surface markings appear only in light of long wave-lengths (yellow to infra-red), whereas clouds and atmospheric effects require short-wave light to render them visible in the photographs. This is the reverse of what might be expected, especially as the prominent rim light in the ultra-violet photographs seems to point to the existence of a strongly scattering atmosphere. The decrease of diameter in the infra-red photographs, discovered by Wright in 1924, is confirmed. The method appears to be a very valuable one for studying atmospheric conditions in Mars, and a further discussion of the photographs will be awaited with interest.

Research Items.

The Peopling of the Earth.—Dr. Aleš Hrdlička in No. 3, vol. 65, of the *Proceedings of the American Philosophical Society*, reviews conclusions on the place of origin and distribution of man put forward in 1921 in the light of the evidence collected by him in his recent journey through parts of Europe and Asia, Australia, and South Africa. On the question of the origin and cradle of mankind, he holds to the view that this must be sought in western and south-western Europe, with probably an early extension of the species, on one hand towards central Europe, and on the other, over the watershed of the Mediterranean. It is probable that by the time the last or Würmian glaciation was approaching, man existed in only one general form—the Neanderthal, which persisted for a very long time into post-glacial times. The view that Neanderthal is a separate species which completely died out is erroneous. It is a necessary stage of man's evolution, and if *Homo sapiens* is given another place of origin, say Asia, a Neanderthal phase must be postulated there. Probably he became much reduced in numbers in western Europe and his place was taken by transitional Aurignacian man who was nearing the modern type, having developed from an extension of the Neanderthal eastwards beyond central Europe, which afterwards returned westwards as Aurignacian man to the place of his Neanderthal forefathers. After the last glacial period there is a rapid extension of culture, and man for the first time in his history becomes capable of furnishing a surplus of numbers needing an extension of his domain. It was during this time that the foundation was laid for man's differentiation into the older human stocks and races. Apart from the corroboration of the above views, three, or rather four, conclusions emerge as a result of Dr. Hrdlička's journey. A link between the Negritos of Africa and of south-eastern Asia has been found in India; it is clear that the Australian (and Tasmanian) is one of the more fundamental races of the world with close connexion with our own ancestral stock; there are in Asia remnants of the old yellow-brown stock from which is derived the American Indian, *e.g.* the Tibetans; and lastly, in Australia and South Africa new types of white man are developing.

Northern Tungus Migrations.—An examination of the ethnological affinities of the Goldi of the Amur and Ussuri rivers by Prof. S. M. Shirokogoroff in Vol. 57 of the *Journal of the North China Branch of the Royal Asiatic Society* has afforded the author an opportunity to offer suggestions towards the elucidation of the obscure question of the date and course of the various Tungus migrations. The Goldi, sometimes known by the Chinese name of *Yu-pi-ta-tse*, *i.e.* Fish-skin Barbarians, on account of the use of this material for articles of dress, belong to the southern branch of the Tungus linguistic family; their language may perhaps be regarded as a branch of spoken Manchu, but it shows elements characteristic of northern Tungus dialects. Their culture shows traces of the northern Tungus complex, as well as of Palæasiatic influence. Recently, Chinese influence has been brought to bear upon them by colonisers. From neolithic times to the present day their territory, it is known, has been the scene of struggles between various groups, Palæasiatics, Koreans, Mongols, Tungus, and, later, Chinese. Archæological evidence—walled cities, cemeteries, etc.—shows that at times it has been thickly populated. A comparative study of the cultural and linguistic elements of the Goldi complex shows that this people is of mixed character and origin, which may be explained as an absorption of the northern Tungus, who went from north and west to the south and east, by the southern Tungus and perhaps Palæasiatic groups. Four different waves of Tungus migration can be distinguished. The first wave occurred before the tenth century, and brought various groups of northern Tungus, probably reindeer breeders and including the Goldi, to the lower Amur, Ussuri, and Sunjari basins. The second wave, about the twelfth century, occupied the territory left by the reindeer breeders. A third wave in the seventeenth century, after the Manchus depopulated the Amur valley, led to certain tribal redistributions in and about eastern Transbaikalia. The fourth wave, which began in the nineteenth century and still continues, is one in which the last of the northern Tungus stock living south of Yakuts are moving eastward into the Amur Government and on to the Manchurian plateau.

Ancient Ships.—The ships of early explorers were described by Mr. G. S. Laird-Clowes in a recent lecture to the Royal Geographical Society, in which he pointed out how imperfect is the record of early shipping, not merely in actual specimens but also in pictorial representation. Among early forms of vessels the only ones that have been preserved are one or two small Egyptian processional boats; two Roman vessels, not yet raised from the bottom of Lake Nemi; a portion of a lighter of about A.D. 270 found in the Thames; a Frisian ship; and two Viking ships. In the British Isles, beyond the Thames lighter and some dug-outs of doubtful age, there is nothing earlier than a barge of the time of William and Mary, another nearly a century later, and then Nelson's *Victory* and the *Implacable*; or as Mr. Laird-Clowes puts it, there is a blank in the preservation of actual ships from Roman times until the seventeenth century. The pictorial record is less inadequate, but it consists largely of ships broadside on and so gives comparatively little detail of the build and method of construction. Moreover, it is concerned mainly with large ships; the small vessels, which were of chief importance in exploration, were seldom drawn in any detail.

Grafting in Planaria.—Prof. H. W. Rand and Amy Browne describe (*Proc. U.S. Nat. Acad. Sci.*, vol. 12, Sept.) the technique they have employed in their grafting experiments on *Planaria maculata* undertaken with the view of ascertaining whether regeneration of a head at an exposed anterior cut surface may be inhibited by the presence of a head grafted relatively near this cut surface. The difficulties of the grafting operation arise from the extreme softness and delicacy of the tissues, the mobility of the pieces and the contamination of the cut surface with mucus. A 3·5 per cent. solution of pure acid-free gelatin in distilled water was made and allowed to cool until it began to stiffen, and was then poured on to cold glass slides where it set, forming a layer about 1 mm. thick. Two Planaria, preferably narcotised by chloretone, were taken, and from the side of the body of one was excised a piece of tissue, leaving a wound appropriate in size for the reception of the graft. The wound was made deep enough to interrupt the lateral nerve cord. This animal having been placed on the prepared gelatin surface, the head was immediately excised from the second Planaria and placed with its cut surface against the wound surface of the first one, and strips and fragments of moist gelatin were packed tightly around to prevent separation of the grafted head from the body. The slide was placed in a moist chamber for 18 to 24 hours, after which the gelatin was carefully picked away and the graft compound transferred to a small dish of pond water. Eight successful grafts of a head on to the side of a body were obtained. After the graft had become well healed in place, the animal's original head was removed. The question was: Will the presence of the foreign head in close proximity to the wound affect the regeneration of a head which would take place in an ordinary beheaded Planaria? In one case the stock head was removed and regenerated five successive times, but in other cases it would appear that retardation and inhibition of regeneration was due to the presence of the grafted head.

New Mollusca from Mexico, Central and South America.—Three short papers are before us dealing with new mollusca from these regions. Mr. W. B. Marshall describes eleven new species of "Land and Fresh-water Mollusks from Central and South America" (*Proc. U.S. Nat. Mus.*, vol. 69, art. 12) belonging to the genera Cyclodina, Succinea, Ampullaria, and various Unionidæ. Dr. Paul Bartsch, in continuation of a paper published in 1924, treats of "Additional new Mollusks from Santa Elena Bay, Ecuador" (*Proc. U.S. Nat. Mus.*, vol. 69, art. 20). As in the original note, they are marine genera, mostly Turbonilla, Pyramidella, and Odostomia. The same author also writes on some "New Urocoptid Land Shells from Mexico" obtained by Mr. C. R. Orcutt during his recent botanical explorations (*Proc. U.S. Nat. Mus.*, vol. 70, art. 4). Sixteen species of Holospira supposed to be new are described and illustrated.

Botany and Hydrology.—Oscar Edward Meinzer has investigated the uses of plants as indicators of ground water (*Jour. Wash. Acad. Sciences*, vol. 16, No. 21, 1926). He groups desert plants into two general classes according to the adjustments they make for the scarcity of water. On one hand are the true xerophytes, depending for their scanty supply of water on the rains that occur at long intervals, and during periods of drought maintaining themselves in a nearly dormant condition; on the other hand are those plants, termed by the author "phreatophytes" or "well plants," which grow where they can send their roots down to the water table. These plants group themselves in zones and communities according as the topography of the surface varies the depth of the water table. Thus salt grass (*Distichlis spicata*) indicates water 8 ft. to 12 ft. from surface, while mesquite (*Prosopis juliflora*) can reach water so far as 50 ft. below ground. After twenty years of hydrological work, and contrary to popular belief, the author is unable to establish any definite relation between the occurrence of phreatophytes and the quality of the ground water, or to suggest that any species that can grow in even moderately alkaline soil will invariably indicate potable water. Even in desert country, a substantial supply of water is thus available, and the loss of water per acre due to transpiration is probably less than the quantity required to irrigate useful crops. Pumping, however, is an expensive operation, and it is suggested that those hundreds of thousands of acres of desert land should be made productive rather by the cultivation of such promising phreatophytes of economic value as alfalfa (for seed mostly), Bermuda grass, and pecan.

Recent Lowering of Sea-level.—It is well known that Daly has presented evidence supporting the view that a world-wide lowering of sea-level, amounting on an average to about six metres, has taken place during post-glacial time. This has been recently extended by the observations of Wentworth and Palmer on the islands of the North Pacific. They find a lowering of the ocean level of 12 to 15 feet. W. A. Johnston, however (*Am. Jour. Sci.*, 1926, p. 253), has failed to find evidence of such a relative movement along the Pacific Coast of Canada. A further contribution to the subject of recent movements of the strand line is now made by A. F. Buddington in the *Am. Jour. Sci.*, 1927, p. 45. He has examined more than four thousand miles of coast in south-eastern Alaska, and he states that wherever the conditions have been favourable, remnants of relatively uplifted sea-cut rock benches are found near the present level of high tide. The estimated lowering of sea-level is between 12 and 16 feet. This, however, is but the last of a series of post-glacial uplifts. Near Juneau, old beach deposits have been found at elevations of 600 feet or more, and well-marked platforms produced by marine planation occur at various levels up to 200 feet.

Land Movements during the Japanese Earthquake of Sept. 1, 1923.—The remarkable elevations and depressions measured in the bed of Sagami Bay have already been referred to in Nature (Mar. 29, 1924, vol. 113, pp. 473-474). The corresponding movements on land form the subject of a valuable paper by Major-General H. Omura, of the Land Survey Department (*Bulletin of the Earthquake Research Institute*, vol. 1, 1926, pp. 65-68). Immediately after the earthquake this Department began the revision of precise levelling, and during the following years, from 1924 onwards, it has been engaged in carrying out a revision of the triangulations over the central region. The admirable map which accompanies the paper shows the changes of level in the land surrounding Sagami Bay, zones of uplift and depression for every fifth of a metre being represented, from +2 metres and upwards to −1·2 metres and below. The more important elevations occur along the coast of Sagami Bay and in the Boso peninsula. The main area of depression lies inland to the north-west of the bay, and it is noteworthy that one of the principal zones of depression is about 30 miles north-north-west of the centre of the first disturbance, that is, it is close to the centre of the second movement (see Nature, Jan. 22, 1927, vol. 119, p. 139).

Igneous Rocks of Mount Girnar.—More than twenty years ago Dr. J. W. Evans made a representative collection of rocks from the Girnar and Osham Hills in Kathiawar. A systematic examination of the types represented has now been made by M. S. Krishnan, and his results are published in the *Records of the Geol. Surv. India*, 58, 1926, p. 380. Almost simultaneously a field and structural study of the Girnar rocks appeared in the *Journal of Geology*, 34, 1926, p. 289, by K. K. Mathur, V. S. Dubey, and N. L. Sharma. These two papers taken together have greatly extended our hitherto scanty knowledge of the phases of igneous activity which followed the great outpourings of the Deccan plateau-basalts. At Girnar the basalts were domed up by a laccolith in which olivine gabbro, diorite, and monzonite crystallised. A circular system of fractures around the dome was intruded by granophyre; and, in the gabbro, dykes of nepheline-syenite and lamprophyres are found in close association. The differentiation of the parent magma is attributed to fractional crystallisation, and support is given to Bowen's hypothesis of the origin of nepheline-syenite, involving the removal of orthosilicate molecules by volatile fluxes. A series of analyses is presented by Dr. Krishnan, and it is noteworthy that the variation diagram constructed from the results is of the broken and jerky type which seems to correspond with the suggested process of fractional crystallisation.

Gabb's Californian Fossil Gastropods.—The well-known American palæontologist, W. M. Gabb, described in two volumes, published in 1864–69 by the Geological Survey of California, the fossils collected by the members of that Survey. He did not, however, designate type specimens or indicate type localities, items required in present-day palæontological research, while in some cases his figures were restored and embodied parts of more than one specimen. Mr. R. B. Stewart now seeks to rectify all this so far as the Gastropoda are concerned (*Proc. Acad. Nat. Sci. Philad.*, vol. 78), and after careful study of the original specimens deposited by Gabb with the Academy of Natural Sciences of Philadelphia, and those which had drifted into other collections, has carefully described and illustrated the now selected types. More than 150 species have been dealt with, but 20 are still missing. It has been considered necessary to create 14 new genera. The 13 plates of figures from retouched photographs by Miss H. Winchester are good and should amply meet the requirements of students.

Radio in the Whaling Industry.—The use of radio telephony by fleets of whaling ships has made the whaling industry a much less strenuous one. When one of the vessels, equipped with a ½-kilowatt Marconi telephone set, sights a number of whales, possibly after several weeks' searching, the other ships of the same fleet are immediately informed by telephone, and all can then make for the best spot for hunting. The 'factory ship' that also accompanies the fleet is simultaneously directed to the most suitable position for taking charge of the catches. A simple code is employed, so only the ships concerned can interpret the messages. The apparatus used is highly efficient, as messages have been heard up to distances of two thousand miles. Until a few years ago, whales were caught by harpooning from rowing boats. Now fast steam launches equipped with 1000 horse-power engines are used for the pursuit. Harpoons are projected from guns instead of being thrown by hand. Practically all the carcase is converted into oil, cattle cake, and other marketable commodities. On several ships this season, Marconi direction finders have also been fitted. As the magnetic compass is of little use in the Antarctic regions, these finders, which are independent of the earth's magnetism, have proved of great value. Like the telephone sets, the direction finders are worked by the harpoon-gunner and require no special operator. The Ross Sea, which is enclosed by an ice barrier with only one seasonal outlet, can now be safely invaded and large catches have been made in it.

Detection of Internal Flaws in Rails.—For some years it has been known that it is possible to detect internal flaws in steel samples of uniform section by magnetic means. The method has not hitherto received much attention, since it is necessary to thread on to the end of the sample the magnetising and test coils. A recent improvement which eliminates this difficulty is described in a paper by Masuhiro Suzuki in *Science Reports*, Tohoku Imp. Univ., vol. 15, No. 4, p. 479. The method has been applied to rails actually in service with important results. The magnetisation of the steel is effected by a large horseshoe electro-magnet which rests a very short distance above the surface of the rail on small rollers. Between the poles is one test coil which need only be placed on the surface. Any irregularity in the rail is then detected by a deflexion of a galvanometer connected to this coil as the whole apparatus is traversed along the rail. Flaws, segregated areas, and overstrained regions are then readily detected. The latter is an important point, since portions of the steel which, although not yet actually flawed are potential flaws, are clearly picked out. As an example of this may be mentioned periodic irregularities found in a new rail free from marked segregation or flaws. The author ascribes these to the effects produced in the rail-straightening process after it had been rolled. Although the present work is confined to rails, the modified method is applicable to a large number of similar examinations such as tyres and ropes.

Thermal Decomposition of Ozone in the Presence of Hydrogen.—R. O. Griffith and K. McKeown have extended their experiments on the catalytic effect of gases on the thermal decomposition of ozone to include the effect of hydrogen on the same reaction at 78° and 100°. Details of the work have been published in the *Journal of the Chemical Society* for Dec. In addition to the deozonisation process, water is formed by the reaction, $H_2 + O_3 = H_2O + O_2$, and the interpretation of the results is more difficult. The velocity coefficients of the two reactions show that the catalytic effect of the hydrogen is positive, and a possible explanation of the results, involving a series of intermediate reactions, is given.

Effect of Sunlight on Cotton.—The effect of sunlight on cotton fabric is the subject of No. 1016 of the Aeronautical Research Committee's Reports and Memoranda (London: H.M. Stationery Office, 1926. 1*s.* net), by G. Barr and Isabel Hadfield. It has been found that the determination of the viscosity of a solution of cotton in cuprammonium hydroxide forms a much more sensitive method of following the deterioration in sunlight than that used in the past, namely, the change in tensile strength. After exposure, the cotton shows increased reducing properties, and it is evident that chemical and not merely physical change has taken place, although further work on fabric exposed in the absence of oxygen is necessary before it will be possible to decide to what extent the change in the fabric is an oxidation process.

A New Transformation of Cobalt.—Measurements have been made by Hakar Masumoto (*Science Reports*, Tohoku Imp. Univ., vol. 15, No. 4, Oct. 1926) of the electrical conductivity, thermal expansion, heat changes, and magnetic properties of cobalt at high temperatures. For the purest sample, all of these show a discontinuity around 477° C. on heating and 403° C. on cooling. From X-ray analysis it is shown to be probable that below this temperature cobalt crystallises as close-packed hexagonal material, while above it is face-centred. Both forms are ferromagnetic. The effects of iron and nickel on this change have been investigated, and in each case the added metal lowers the temperature of the change rapidly. Especially is this the case with iron, about 4 per cent. of which element lowers the change point to 0° C. Some observations are made on the changes in the iron-cobalt and nickel-cobalt systems respectively which occur below the solidus. So far as the latter alloys are concerned, they appear to form one series of solid solutions throughout. The system iron-cobalt is more complex, and as the iron content is raised the structure at room temperatures passes from close-packed hexagonal to face-centred cubic, and then finally to body-centred cubic at about 21 per cent. of iron. In each case there is a small zone in which the mixed phases are found.

Meteorology and Air Routes.

THERE are few forms of transport which are not influenced to some extent by meteorological conditions, but there is none which makes greater demands on meteorological science and practice than the aeroplane and the airship. The importance which is attached by the Air Ministry to the provision of the necessary meteorological advice and organisation in connexion with the development of Empire air routes is rendered evident by a document recently issued under the title of "The Approach towards a System of Imperial Air Communications" (H.M. Stationery Office, price 5s.). This document consists of the memorandum by the Secretary of State for Air laid before the Imperial Conference, 1926, together with the report of the Imperial Air Communications Special Sub-Committee. The memorandum contains appendices giving a clear statement of the principles governing the application of meteorology to air navigation, both as regards investigational work and as regards the provision of a ground organisation along the routes. At the same time, the main portion of the memorandum sets out, in the section on airships, some general remarks on the bearing of meteorological conditions on airship navigation, supported by very interesting examples of the results to date of an intensive meteorological investigation of the projected England-Egypt-India airship routes, illustrated by charts well reproduced in colours. Meteorological work for airships is in the hands of a specially created division of the Meteorological Office, and it is hinted that the aim of the work on the England-India routes is to provide for the airship pilot, information in atlas and handbook form analogous to that which has long been available to seamen.

Examples of average thunderstorm and upper wind conditions show that the 'normal' routes may differ outward and homeward, and also from month to month. Further, the pilot will find that in particular cases departures from the 'normal' route for the month will be advantageous. The memorandum reminds us that "the air and its currents are to the aircraft what the oceans and their currents are to the ships, . . ." and proceeds: "A high wind, even of gale force, should cause no more danger or discomfort to an aircraft in flight in free air than an increase of speed in an ocean current to a surface vessel in mid-ocean; but there are, however, certain atmospheric disturbances, such as tornados or waterspouts, and violent vertical currents associated with thunderstorms and line-squalls, which do constitute a potential source of danger to airships." It is then pointed out that these must be avoided by suitable choice of route, the report continuing: "It is particularly on long-distance airship flights that such alteration of route will be made in order to avoid adverse and utilise favouring weather conditions. It will, in fact, be the rule rather than the exception, for the commander of an airship to choose his route between any two points for each separate flight, having regard to the meteorological conditions prevailing at the time." An example is reproduced from a special series of daily weather charts for a whole year covering Europe, N. Africa, and a large part of Asia, being prepared from past data to study such problems. This shows how the pilot, given the weather chart and forecasts, could have made a quicker passage in better weather from London to the Mediterranean via the west coast of France than by the more direct route viâ the Rhone valley.

It is not alone the navigation of airships which has made demands on meteorology. Airship mooring is requiring, for its ultimate perfection, a knowledge of the finer wind and thermal structure of the lower layers of the atmosphere and the changes with time, beyond that existing at present. The former is being investigated at Cardington (Beds.) by a special network of electrically synchronised anemometers with very open time-scale, while it is proposed to instal instruments on a mast at Ismailia (Egypt) to give a continuous record of the lapse-rate of temperature in the first 200 feet or so above the desert surface. It is thus evident that airship development is calling for information which is of very special interest to meteorologists, so that the science of meteorology should itself benefit considerably in meeting these demands.

Attention has not been confined to the England-India airship route. An appendix contains the results of a preliminary survey of meteorological conditions with the view of delimiting areas within which main Imperial airship routes may be expected to develop, and these are shown in a chart. The flying areas are in the form of strips, some hundreds of miles wide, extending from base to base. They lie mostly over the sea. In addition to the routes to Canada across the North Atlantic, there are alternative routes to South Africa, namely, via the west coast and via the Red Sea and east coast. Australia and New Zealand are reached both from South Africa and also as an extension of the England-India route. The passage from South Africa is outward by the northern boundary of the 'Roaring Forties' and back in the south-east trade belt. That from India to Australia is wholly across the ocean to south-western Australia, avoiding the well-known Java thunderstorm area.

The recommendations of the Imperial Air Communications Sub-Committee, afterwards adopted by the Conference, take cognisance of the importance of active co-operation of the Dominions in providing meteorological facilities if Imperial Air Routes are to be developed successfully.

Mycology in Great Britain.

THE British Mycological Society is one of the most vigorous scientific bodies in Great Britain, and this is reflected in its Transactions, of which vol. 11, Parts 1 and 2, edited by Carleton Rea and J. Ramsbottom, has recently been published (London: Cambridge University Press, 15s. net). Amongst its most useful activities are the spring and autumn forays, when members visit some specially chosen locality and spend several days studying lichens, mycetozoa, and fungi in the field. These forays are almost unique training grounds for students of systematic mycology, and at the same time give opportunity for the very valuable work of recording local floras and thus adding permanently to mycological science. The published lists, as for example those of the Tintern and Dublin Forays of 1925 which appear in this issue, nearly always show a number of additions to the British flora and not infrequently species new to science.

The present issue contains the president's address, which is of interest as giving the views of a herbarium systematist on certain controversial problems. That such a one can write "one of the great hopes of the systematist is the phytopathologist" shows a very commendable broadening of a point of view more usual in herbaria. Mr. Ramsbottom discusses the 'species concept' at some length but in what cannot be regarded as a very helpful manner, and his suggestion that Prof. Lotsy is a writer of undergraduate essays on this subject is wide of the mark. The more important portions of the address are those in which attention is directed to the widespread occurrence of heterothallism and hybridisation in fungi and to the increasing acceptance of behaviouristic criteria in specific delimitation.

The question of heterothallism has been studied by Dr. Derx, who records its occurrence in the genus Penicillium. Problems of strain and species in the genus Colletotrichum are discussed in relation to diseases of certain tropical crop plants by Dr. Small and Mr. M'Donald in two very interesting papers.

Dr. Petch of Ceylon, surely one of the most voluminous writers on mycological topics, continues his monumental series of studies in entomogenous fungi, dealing in the present paper with *Aegerita Webberi*. The same author also contributes an interesting paper on Matula. Dr. Petch's line-drawings are models of what such illustrations should be.

Miss Lorrain-Smith's note on lichen-dyes will be of use to the many people nowadays who are interested in the home-dyeing of hand-woven fabrics. From time to time, controversy has arisen as to the possible harmful effects of feeding bunted grain to stock, and as the result of thorough trials, Mr. Dobson is able to show that, from the point of view of the practical stock feeder, the danger is negligible.

The introduction of any new fungus pest is of importance, more particularly when, as in the present case of the downy mildew of the hop (*Pseudoperonospora Humuli*), every stage of its invasion of England is known. Mr. Ware has discovered the interesting fact that this fungus can overwinter in the rootstock, and from that region invades developing shoots in early spring. An interesting paper by Mr. Maxwell and Dr. Wallace deals with the classical disease of black rust of cereals, *Puccinia graminis*, which was one of the first species of fungus in which strains specialised to particular hosts were described, and five of these (sp. f. Tritici, Secalis, Avenæ, Agrostidis, Phlei-pratensis) are now recorded for Scotland. The obligate relation of the fungus to the barberry plant is also confirmed. Mr. Dowson describes an interesting core-rot and premature fall of apples associated with the fungus *Sclerotinia fructigena*, and Mrs. Alcock discusses the important and somewhat neglected phenomenon of successional disease in plants. She shows clearly how *Cryptomyces maximus*, which is a parasite, weakens *Salix fragilis* so that *Scleroderris fuliginosum*, a semi-parasite, can attack it. This in turn so weakens the tree that such a fungus as *Myxosporium scutellatum*, which is mostly a saprophyte, can then invade the tissues.

This issue of the Transactions opens with a fine portrait of Mr. Cheeseman, the president elect of the Society in 1926. Mr. Cheeseman was the type of amateur field-naturalist to which botanical science in England owes so much. Such men are now, unfortunately, all too rare, and Mr. Cheeseman's untimely death removes one who can little be spared in mycology. Many of us will remember him, in addition, as a very fine type of English gentleman. W. B. B.

Forest Administration in British Honduras.

BEFORE the War, forestry administration in many British smaller colonies and dependencies remained a dead letter. The governors were either men trained to diplomacy or distinguished soldiers. If consideration was given to the matter, it was dismissed with the argument that forestry would not pay. That the argument was fallacious can already be demonstrated by practical examples. For many years British Honduras has been noted for its mahogany, which was extracted on the principles that have destroyed so many forests in the world. Four years ago, the first attempt at introducing a forest administration into the country was made—not without many doubts as to the wisdom of the projected step, both at home and in the colony. A two years' trial was to be made, and three Forest Officers were appointed.

The fourth annual forest report on this new departure has just been issued. From its pages it is easy to see that the young department has already made good. So far, the work has been mainly devoted to assisting the several lumbering companies at work in the forests on government leases. In some respects the operations are proceeding on lines similar to the working of the Burmese forests by the British forest officers of earlier days. Already, however, the work of exploring the government forests, collecting topographical and other details, has been commenced (the superior staff now amounting to six), and it is hoped to be able to carry out the exploration of the practically unknown territory of the Western Highlands. The following remark in the report illustrates how fascinating and valuable this work will prove:

"At the time of writing a reliable base-line has been established between Vaca and the Rio Grande and a good general idea of the forests of this region obtained. The investigation has brought to light the presence of tree species hitherto unknown to occur in the Colony, and types of forest which, though mentioned in the narrative of Fowler and Sapper, have never been closely studied or described." The small staff have already commenced to study the sylviculture of some of the more important species such as mahogany and sapodilla, both at the successful and promising Botanic Station and elsewhere.

It may come as a surprise to many to realise that the forest produce of British Honduras is exported to the United Kingdom, Canada, and Bermuda, in the British Empire, and to the United States, France, Guatemala, Honduras, and Mexico. "The indications," says the Conservator of Forests, "of a developing trade in forest produce with Canada in the form of mahogany lumber, and with the neighbouring republics in the form of pine lumber, are satisfactory features. The general swing of the pendulum from foreign to British markets is governed by movements in mahogany: one would like to regard it as a permanent gain for British trade, but this would not be justifiable." It seems almost incredible that in view of the fact that four-fifths of the Colony's wealth is derived from its forests, the forest officer was only introduced four years ago, and that opposition should still exist to expenditure on the proper conservation and management of the forests; for this work, to be successful, will require a far larger staff than at present exists.

In the interests of the Empire it would be of value if the leaders responsible for the coal strike would give consideration to the following remark in the report: "The effects of the Coal Strike are at least in part responsible for a set-back in the price of mahogany." The report displays unmistakably the great possibilities of development in front of this Colony. The Conservator's attention may be directed to the oft-reiterated suggestion that vernacular names of trees, without their scientific ones, and also local vernacular terms untranslated, detract from the value of such reports outside the Colonies for which they are written.

University and Educational Intelligence.

Cambridge.—The late Prof. E. G. Browne has bequeathed to the University the sum of £2000 for the promotion of the study of the languages, literature, history, and religion of the Arabs, Persians, Turks, or other cognate Asiatic peoples.

The Gordon Wigan Prize for research in chemistry has been awarded to W. A. Waters, Gonville and Caius College, for an investigation on "Substitution in the Diphenyl Series." E. J. H. Corner, Sidney Sussex College, has been nominated to occupy the University table at the laboratory of the Marine Biological Association at Plymouth in March next.

Proposed regulations for the new professorship in political science have been published. Amongst points of interest are the proposals that the professor shall be excused residence in the University for one term in each year, if his absence is for the purpose of studying the working of political institutions or the development of political theory, and that grants may be made from the income of the endowment of the chair to the professor towards his travelling expenses or to students for purposes of travel or research.

Edinburgh.—Dr. F. G. Banting, professor of medical research in the University of Toronto, has been awarded the Cameron Prize in recognition of his investigations on insulin and on the treatment of diabetes. This prize, which was founded in 1878, "may be awarded annually to a person who, in the course of the five years immediately preceding, has made a highly important and valuable addition to Practical Therapeutics."

London.—The title of professor of psychology in the University has been conferred on Dr. Beatrice Edgell, in respect of the post held by her at Bedford College. The title of reader in psychology was conferred on her in Feb. 1913. She is the author of "Theories of Memory" (1924), "Mental Life" (1926), and numerous papers in the *Proceedings of the Aristotelian Society*, *Mind*, and similar publications.

Three further courses of free public lectures are announced, namely, "Allergic Diseases caused by Factors of Climate," by Prof. W. Storm van Leeuwen (University of Leyden), at the Sherrington School of Physiology, St. Thomas's Hospital, at 5 o'clock on Feb. 14, 15, and 16; "The Ostracoderms, their Organisation and Relationships," by Prof. E. A. Stensio (of the Royal State Museum of Natural History, Stockholm), at University College, at 5.30 on Feb. 17, 18, 22, and 24; "Trigonometrical Series," by Prof. G. H. Hardy, at the Imperial College of Science and Technology, at 5.30 on Feb. 17, 24, and Mar. 3.

Oxford.—The first professors of Oxford to receive the title 'emeritus' under a new statute are two former occupants of the Linacre and Sherardian chairs Dr. Gilbert Bourne and Dr. Sydney Vines. The qualification is an automatic and a curious one, namely, "at least 15 years' service as professor." Under this clause of the new statute, Dr. Bourne's great predecessor, Sir Ray Lankester, would appear not to be eligible for the new title, whereas nearly one-half of Oxford's professors of botany are easily, if posthumously, emeritus, their years of service having been: Bobart, 36 years; Humphrey Sibthorp, 37 years; Williams, 38 years; Daubeny, 33 years; Vines, 31 years.

In the Regulations for the Memorial Prize founded in memory of Prof. Rolleston and open to members of the Universities of Oxford and Cambridge, the title of the subject has been redefined as for zoology and comparative anatomy instead of for human and comparative anatomy.

Tate scholarships at the Battersea Polytechnic in engineering, science, and domestic science, ranging in value from £20 to £30 a year, with free tuition and tenable for three years, will shortly be awarded. The examinations for the scholarships will begin on June 14. The latest date of entry is April 23.

The Sir John Cass Technical Institute, Jewry Street, Aldgate, London, E.C.3, is celebrating its twenty-fifth anniversary on Feb. 21, when the Institute will be open for inspection. A number of exhibits and demonstrations has been arranged in the laboratories by students and by manufacturers of scientific and other apparatus.

Ranging from Feb. 21 to April 1 inclusive, a series of twelve free public Swiney lectures on geology will be given by Dr. W. T. Gordon in the lecture theatre of the Imperial College of Science, South Kensington, under the title of "The Origin and Structure of Rocks." The lectures will be delivered at 5.30 on Mondays and Fridays. No tickets will be required.

The Council of the Royal Statistical Society will this year award the Frances Wood Memorial Prize, value £30, for the best investigation, on statistical lines, of any problem affecting the economic or social conditions of the wage-earning classes. Particulars can be obtained from the honorary secretaries of the Society, 9 Adelphi Terrace, W.C.2, not later than Oct. 31.

The University of London Animal Welfare Society, which has been formed to arouse interest in the welfare of animals among university students and teachers, has arranged a series of four public lectures by Major R. F. Wall on the care of domestic animals. The lectures are being delivered at Birkbeck College, London, on Feb. 9, 16, and 23, and Mar. 2, at 5.45 P.M. On Feb. 25, at 5.30 P.M., a discussion on the humane slaughtering of animals will be opened by Prof. G. H. Wooldridge, at King's College. By the rules of the Society it is precluded from taking part in controversies relating to vivisection. The honorary secretary is Capt. C. W. Hume, 14 The Hawthorns, Finchley, London, N.3.

The West of Scotland Agricultural College annual report for 1925–26 records an increase in enrolment in central classes at Glasgow from 265 to 334, while the number of students in central classes at Kilmarnock (chiefly dairy and poultry schools) decreased from 292 to 277. The extension work included lectures and demonstrations with 35,661 attendances and 11,297 visits to farms, etc., by members of the College staff. Attention is directed to an important bequest by Mr. Colin Thomson for research work in connexion with the College and, in particular, with its dairy school at Kilmarnock. A first allocation proposed to be assigned under the bequest by the trustees amounted to £20,000, which is as much as two-thirds of the annual income of the College. A list of appointments gained by students during the year includes several in distant parts of the Empire: Canada, British West Indies, East and West Africa, the Sudan, the Federated Malay States, and Hong Kong. The report of the North of Scotland College of Agriculture records an attendance of 72 students at central classes, while extension work included lectures and demonstrations with 45,557 attendances, 14,135 visits to farms, etc., and 34,735 attendances at systematic and continuation classes.

Calendar of Discovery and Invention.

February 14, 1748.—The two great discoveries of Bradley were those of aberration and nutation. Both resulted from his attempt to determine the parallax of the stars. Aberration was discovered in 1727; he recognised nutation twenty years later, his discovery being made known in a letter dated Feb. 14, 1748, addressed to the Earl of Macclesfield. Bradley at that time was Astronomer-Royal, having succeeded Halley in 1742.

February 14, 1876.—In his attempts to transmit musical sounds by electricity, Alexander Graham Bell in 1875 devised a harmonic telegraph, in which reeds at the receiving end were set in motion by electro-magnets. It was an irregularity in the working of this which led Bell to the invention of the telephone. Elisha Gray had also been working at a telephone, and on Feb. 14, 1876, both filed applications for patents with the American Patent Office. It was found, however, that Bell's application had been received first, and a patent was granted him.

February 15, 1615.—Among the early works of interest to the engineer is "Les Raisons des forces mouvantes avec diverses machines . . ." of Salomon de Caus, the French architect. The author dedicated his work to Louis XI. on Feb. 15, 1615. It is in this work that he enunciated the theorem of the expansion and condensation of steam and his application of steam for raising water.

February 16, 1889.—Formally opened in March 1851, Owens College, Manchester, was referred to in 1858 by the *Manchester Guardian* as "a mortifying failure." Its later success was largely due to Roscoe, who had been appointed to the chair of chemistry in 1857. Thirty years later he retired, and in an address dated Feb. 16, 1889, presented to him by his former students, it was said: "For upwards of thirty years you have had the control and direction of the chemical department of the Owens College. You leave it the best-organised and best-equipped school of chemistry in the kingdom, numbering its students by hundreds, and the acknowledged model of the many similar institutions which the success of your own school has called into existence." Roscoe, like Playfair in after life, entered Parliament and was one of the recognised spokesmen for science in Great Britain.

February 17, 1753.—Stephen Gray, a pensioner of the Charterhouse, Dufay, a French military officer, the Abbé Nollet, and Sir William Watson, all transmitted electricity along wires, but the earliest distinct proposal for an electric telegraph is that contained in a letter signed "C. M." in the *Scots Magazine* for Feb. 17, 1753. By some "C. M." is believed to stand for Charles Morrison; by others for Charles Marshall; both of whom lived at Renfrew. The suggested telegraph had an insulated wire for each symbol; the receiver noted the attraction by a ball attached to the wire of a strip of paper about ⅛ inch below it, on which was the symbol.

February 19, 1878.—During the summer of 1877, while engaged in the invention of a telegraph repeater for increasing the speed of sending telegrams, Edison used a metal disc with paper on it on which an embossing point worked by an electro-magnet indented dots and dashes. By reversing the operations and revolving the disc rapidly, musical notes were obtained. This suggested to Edison a means of recording and reproducing the sounds of the human voice, the first sketch of the phonograph being made on Aug. 12, 1877, and a patent being obtained on Feb. 19, 1878. E. C. S.

Societies and Academies.

LONDON.

Royal Society, Feb. 3.—**W. A. Bone, R. P. Fraser**, and **D. A. Winter**: The initial stages of gaseous explosions. Part 1—Flame speeds during the initial 'uniform movement.' A gaseous explosive mixture is ignited at the *open* end of a horizontal tube 2·5 cm. in diameter. So long as the initial flame speed does not exceed about 4000 cm. per sec., there is a definite initial 'uniform movement,' the speed of which, under standard conditions of experiment, was nearly always fairly constant. But with initial flame speeds exceeding such limits, in ethylene-oxygen and acetylene-oxygen mixtures, the flame speed was continuously accelerated *ab initio* until detonation is set up, just as though the explosive mixture had been fired near the *closed* end of the tube. In hydrogen-oxygen mixtures, whilst the uniformity of the initial movement was still maintained, its speed tended to vary. In certain circumstances, a slow 'uniform movement' of flame can be developed in an explosive mixture after an initial period of continuous acceleration. Thus the speed at which a slow uniform flame movement can travel through an explosive mixture cannot be regarded as a physical constant of it, in the same sense as its rate of explosion (that is, detonation).

W. A. Bone, R. P. Fraser, and **D. A. Winter**: The initial stages of gaseous explosions. Part 2—An examination of the supposed law of flame speeds. The mixtures used for the tests have included several complex hydrocarbon and hydrogen-oxygen mixtures, in which the hydrocarbon has been either acetylene, ethylene, or methane; also a series of complex methane-hydrogen-air mixtures, all containing excess of combustible gas, have been examined. When ethylene, or methane was the hydrocarbon used, and the primary mixtures both contained excess of combustible gas, the effect of successive additions of the primary hydrogen-oxygen mixture to the primary hydrocarbon-oxygen mixture (both having the same initial uniform flame speed) is progressively to depress the initial uniform flame speed of the resulting complex mixture, until it refuses any longer to propagate flame. It therefore follows that Payman and Wheeler's 'law of flame speeds' is not generally applicable to gaseous explosions.

A. Egerton and **S. F. Gates**: On detonation of gaseous mixtures of acetylene and of pentane (1). The conditions for detonation to occur in the same place in a tube of certain dimensions have been investigated for acetylene and for pentane mixtures of definite composition. Detonation appears to take place slightly ahead of the combustion front. The 'anti-knock' compounds, lead tetraethyl and diethylselenide, did not affect the position of detonation at ordinary initial pressures and temperatures.

A. Egerton and **S. F. Gates**: On detonation of gaseous mixtures at high initial pressures and temperatures (2). Detonation in acetylene and in pentane mixtures at high initial temperatures (230° C.) and pressures (10 atmospheres) has been investigated photographically, using a steel tube fitted with glass windows. Increase of initial pressure engenders earlier detonation up to a certain limit, when further increase makes very little difference. At a given initial pressure, rise of initial temperature appears to render detonation slightly later. Lead tetraethyl does not affect the position of detonation at high pressure either at normal initial temperature or at 23° C.

W. A. Bone and **A. Forshaw**: Studies upon catalytic combustion. Part 5.—The union of carbonic oxide and other gases with oxygen in contact with a fireclay surface at 500° C. The surface catalyses the combination of (moist) carbonic oxide and oxygen much in the same way as it does that of hydrogen and oxygen at the same temperature, though in a less degree. With a moist mixture of the carbonic oxide and oxygen in their combining proportions, the rate of combination is always directly proportional to the pressure of the dry mixture, provided that the surface is in a 'normal' condition, and the reaction product quickly removed from the system. The catalysing power of the surface can be greatly stimulated, but not permanently, by previous exposure at the reaction temperature to the combustible gas. When the carbonic oxide and oxygen are present in other than their combining proportions, their rate of combination is proportional to the partial pressure of the carbonic oxide. Of hydrogen, carbonic oxide, and methane, the first-named is the most, and the last-named the least, amenable to the catalytic combustion.

M. W. Garrett: Experiments to test the possibility of transmutation by electronic bombardment. An attempt to transmute tin into indium, in a quartz apparatus similar to that used by Smits, proved a failure, in spite of the employment of high current densities and the extraordinary sensitiveness of the spectroscopic method. Indium was detected in all the samples of 'pure' tin examined. The 4102 line was found to be the most persistent in the spectrum of this element (de Gramont lists 4511). Attempts were made to prepare scandium from titanium, using electrons of sufficient speed to be certain of penetrating the *K* ring of this element. Titanium was bombarded with 12,000-volt electrons from a hot filament in an evacuated bulb, but no evidence of any transmutation was obtained.

R. G. J. Fraser: The effective cross-section of the oriented hydrogen atom. Search for a change in the collision area of the hydrogen atom following space quantisation yields a negative result. The hydrogen atom in the normal (1*s*) state is thus isotropic. Spherical symmetry for an *s*-state follows as a necessary consequence of the Schrodinger atom theory; hence the present result, and also the absence of double refraction in space quantised sodium vapour (Schütz), are satisfactorily explained.

L. Pauling: The theoretical prediction of the physical properties of many electron atoms and ions: Mole refraction, diamagnetic susceptibility, and extension in space. The general method followed is capable of refinements which should make possible the accurate prediction of the properties of any atom or ion. The most obvious one is the use of the wave mechanics in determining the state of an electron under the influence of a positive nucleus and several idealised electron shells. Explicit expressions for the properties of an electron in such a state may then be derived, eliminating the necessity of the more or less inaccurate adaptation of the equations obtained for hydrogen-like atoms. Further progress may also be made in approximating an electron shell more closely than is possible with a spherical surface charge. All of these refinements will greatly complicate the treatment.

B. F. J. Schonland and J. Craib: The electric fields of South African thunderstorms. A station for measurements in electrical meteorology has been established at Somerset East, Cape Province, South Africa. Observations have been made of the electric fields and field changes associated with 18 distant and 5 near thunderstorms. The sudden changes of field due to distant lightning discharges (>8 km.) were predominately negative in sign, those due to near discharges (<6 km.) predominately positive. The relative frequencies of positive and negative changes were 1 : 5 in the former case and 4·3 : 1 in the latter. The steady electric fields below the five near storms were all strongly negative. These results indicate that the thunderclouds were bipolar in nature and that the polarity was generally, if not always, positive, the upper pole being positive and the lower pole negative. It is doubtful if any active storms of opposite polarity were observed at all. The mean value of the electric moments of the charges removed by 82 lightning discharges is 94 coulomb-kilometres.

Royal Microscopical Society, Dec. 15.—**Stanley Hirst**: Note on the development of *Allothrombium fuliginosum* Hermann. The six post-embryonal stages are: (1) ovum; (2) prelarval stage; (3) larval form; (4) resting stage of larval form; (5) nymph; (6) adult. The insects are parasitic on aphids both in the immature and adult stages. The adults suck the juices generally of the inert stages of the aphis. They also feed on freshly-killed flies and their maggots. Two species of aphids, *Macrosiphum gei* Koch. and *Myzus persicae* Sulzer, both occurring on the common dock, were used as food for both larval and adult *A. fuliginosum*.—**A. Kefalas**: A method of staining sections in acetone. Two staining solutions are used: (1) Liq. ferri sesquichlor (double B.P. strength), 3 c.c.; pure strong hydrochloric acid, 1 drop; 1 per cent. solution of ripe hæmatoxylin in good acetone, 100 c.c.; (2) is a saturated solution of Biebrich scarlet (Grübler) in acetone. The slides are passed through six stoppered cylinders of the old type containing xylol, acetone, solution (1), solution (2), acetone, and xylol. In solution (1) they are allowed to over-stain slightly. They are mounted in balsam. The method is cheap, rapid, and easy, well suited for routine work, and over-staining does not easily occur. The slides, moreover, are kept in a fixative solution all the time and are subjected to little change in osmotic tensions.—**J. Ramsbottom and E. H. Ellis**: Seedling structure of cultivated orchids. Fungal mycelium occurs in the roots of orchids, and in order to germinate the seeds, they must generally be infected by the same fungus. Germination can also be brought about by sterilising the seeds and supplying them with a nutrient solution containing some kind of sugar. Photomicrographs of numerous orchid seedlings and mature roots, the roots being of native British plants growing wild and of horticultural varieties, were examined. The seedlings showed fungal infection, distribution of the fungus, and 'clumping' of hyphæ in closely parallel series. Some of these seedlings (bi-generic hybrids, etc.) had been artificially inoculated by using cultures of one of the orchid fungi, whereas others had become infected when grown in the ordinary horticultural way. Seedlings of wild British orchids show the same sequence of events, and as the fungus is always the same for one species of orchid, it would appear that the process is an adaptative one and not merely chance parasitism.

Linnean Society, Jan. 6.—**C. Norman**: Pimpinellas of tropical Africa. This Umbelliferous genus is well represented in tropical Africa by about 25 species. It occurs in all parts of the tropical region, usually in open country at an elevation of not less than about 3000 ft., ascending to 10,000 ft. on the mountains. With one exception all the species belong to the subgenus Eu-pimpinella, and they are nearly always found growing amongst grasses in open country. Only one species seems to occur in tropical and southern Africa, and that is the common *P. caffra*, which reappears unexpectedly in Abyssinia.

Mineralogical Society, Jan. 18.—**A. Brammall and H. F. Harwood**: The temperature-range of formation for tourmaline, rutile, brookite, and anatase in the

Dartmoor granite. Applying Wright and Larsen's conclusions concerning rock types in which quartz originated in the *a*- or the *β*-phase, the authors adduce petrological evidence to support the following approximations: The range for tourmaline extends from magma-temperatures *circa* 800° downwards through an optimum range *circa* 600°-300° into an unfavourable range with an undetermined lower limit. The range for rutile is at least co-extensive with that for tourmaline. The range for anatase extends downwards from temperatures connoted by crystallisations from small residual pools of borosilicate flux accumulating at a late stage in the consolidation of the granite ground mass, to temperatures at which simple hydrolysis of biotite occurs. The range for brookite lies within that for anatase. For each species, extension of the range downwards may be necessary to cover cases of suspected authigenic growth in sediments.—**A. Russell**: Notice of an occurrence of niccolite and ullmannite at the Settlingstones Mine, Fourstones, Northumberland; of stichtite at the Island of Unst, Shetlands; and of serpierite at Ross Island Mine, Killarney, Co. Kerry, Ireland. In working a body of galena in the witherite vein of Settlingstones mine, a small quantity of very rich niccolite intimately associated with ullmannite, blende, galena, and witherite, was met with. Polished sections of the ore show the niccolite in roughly spherical to botryoidal forms, often surrounded by fringes of ullmannite and associated with brown blende and white witherite. Minute cubes of ullmannite occur in the witherite. Stichtite occurs in characteristic fibrous lilac-coloured specimens associated with kämmererite and chromite in serpentine at the "Kämmererite Quarry," Nikka Vord, Balta Sound, Island of Unst, Shetlands. The rare mineral serpierite occurs in cavities in cellular calamine ($ZnCO_3$) on the old dumps at Ross Island Mine, Killarney, Co. Kerry, Ireland. It forms small greenish-blue spherical aggregates composed of minute crystals flattened parallel to *c*(001) and elongated in the direction of the *a* axis.

Geological Society, Jan. 19.—**L. J. Chubb**: The geology of the Austral or Tubuai Islands (Southern Pacific). This group is situated about 350 miles south of Tahiti, and 1800 miles north-east of New Zealand. It includes seven islands, of which four are here described. Rapa is a crateriform island, the slopes of which have been deeply dissected by radial streams, while the ends of the spurs between the valleys have been strongly cliffed by the sea. After one of the radial streams had captured the drainage of the crater, the island was submerged, with the result that the river-valleys were embayed, and the crater flooded. Afterwards slight elevation occurred. Marotiri consists of a number of needle-like stacks rising out of the sea, and situated roughly on the circumference of a circle. Probably it represents the last stage of an island of the type of Rapa which has subsided. Rurutu is without the sharp peaks and serrated ridges characteristic of Rapa, and the valley-mouths are not embayed. The history of the island appears to be one of frequently-renewed, intermittent elevation, stationary periods being indicated by raised plateaux, and the different degrees of weathering of the rocks at different levels. In the later stages a fringing-reef came into existence, which was finally uplifted. A narrow fringing-reef has developed around the island in recent time. Rimatara is surrounded by a coral-reef about 2 miles wide. The outer edge of the central island is occupied by an elevated reef, which faces the sea in a line of cliffs 20 or 30 feet high. The islands are arranged along lines having a general west-north-westerly and east-south-easterly trend; their movements of elevation and subsidence may be due to their being situated on a submerged anticlinal fold, the crest of which has moved northwards.—**W. Campbell Smith** and **L. J. Chubb**: The petrography of the Austral or Tubuai Islands (South Pacific), with chemical analyses by **E. D. Mountain**. Except for a few small local occurrences of pyroclastic rocks, the volcanic rocks of Rapa consist of phonolitic and basaltic lavas invaded by many dykes and other small intrusions. Of the latter, the most interesting probably forms the plug in the vent of the main volcano. It is an extremely melanocratic olivine-theralite. The basic porphyritic basalts are the predominant lavas: they resemble the picritic basalts of Hawaii and the ankaramites (ultrabasic basalts) of Tahiti. All the acid and basic lavas compare very closely with rocks from Tahiti, while rocks comparable with the trachybasalt and the basic andesine-andesite have been described from Hawaii. In Rurutu occurs an olivine-bearing nepheline-tephrite, which resembles a rock described from Franklin Island (Antarctica). Otherwise the basic lavas found in this island are similar to those of Rapa.

EDINBURGH.

Royal Physical Society, Jan. 17.—**A. C. Stephen**: A short list of mollusca collected off Franz Joseph Land and Spitsbergen by the British (Algarson) Arctic Expedition, 1925.—**A. W. Greenwood**: Pterylosis in the 'hackleless' fowl. A study of the distribution and development of plumage in the 'hackleless' fowl does not support the view that this is an example of the inheritance of an acquired pathological condition. The condition appears to be genetic in origin and is due to the complete absence of feather follicles in certain areas of the body.—**Miss J. S. S. Blyth**: The Manoilov reaction for the identification of sex and its application to the case of the sexually abnormal fowl. It can be shown that the Manoilov test is not an all-or-none reaction but a quantitative one. The intersexual individual gives a reaction intermediate between that of the normal male and the normal female, and varying with the degree and type of sexual abnormality.

MANCHESTER.

Literary and Philosophical Society, Jan. 11.—**W. H. Lang** and **Isabel C. Cookson**: Some early palæozoic plants from Victoria, with comparative remarks. These specimens have been brought from the collections of the Geological Survey of Victoria and the National Museum, Melbourne, for comparison with British pre-carboniferous plants. They were found in rocks of the Wallhalla syncline in the Gippsland region that are usually regarded as of Yeringian (Upper Silurian) Age. On palæontological grounds the chief plant-containing beds are, however, believed by Mr. F. Chapman to belong to a higher series, which he terms Tanjilian; the Geological Survey on stratigraphical grounds places these beds at a lower level in the Yeringian. While the geological age of the beds must largely depend on their animal fossils, it has been rightly pointed out by Chapman that the plant-remains would support an age considerably later than the Silurian. They include stems of uncertain affinity with crowded, long, simple leaves; shoots with small leaves or spines which have been described and figured as Arthrostigma, but appear more closely comparable with the Middle Devonian plant Thursophyton; smooth-branched axes that resemble those from the Middle Devonian which are known as *Hostimella sp.*, and sometimes even agree with these in the presence of a 'bud-like' structure in the axil of the branch; and fragments that may be of such plants, though the possibility of the occurrence of Nematophyton must be kept in mind. The flora, as represented by these specimens, on the whole suggests comparison with that of the Middle Devonian or Middle Old Red Sandstone of the northern hemisphere. Its occurrence in rocks along with a Silurian fauna raises interesting problems.—**E. J. Williams**: The passage of α- and β-particles through matter. Experimental results for the number of ions per unit length of track produced by β-rays (velocity about 5×10^9 cm./sec.) in hydrogen, nitrogen, and oxygen are given. The theoretical values, according to Sir J. J. Thomson's theory, account for only about one-half of the observed ionisation. New calculations are given in which the motion of the atomic electrons is taken into account. The necessary data for the calculation of the theoretical values are most certain for hydrogen, and in this case the new theoretical value is within experimental error of the observed value. In discussing stopping powers, values for β-rays recently obtained by Mr. Nuttall and the author are used. These are free from errors arising from scattering. The relation between the atomic stopping powers for α-rays and those for β-rays are discussed. Bohr's theory does not represent the facts. Allowance for the motion of the atomic electrons decreases the discrepancy between Henderson's theory and the observations, about 80 per cent. of the stopping power being thus accounted for. The residual discrepancy is probably real and it may be greater for α-rays than for β-rays.

Paris.

Academy of Sciences, Jan. 4.—**Gaston Julia**: The means of the moduli of analytical functions.—**Jean Thibaud**: The various crystalline forms of long-chain organic compounds and the difficulties of interpretation of their X-ray spectra. The interstice *d* of an organic substance capable of orientation, taken as an analytical character, is subject to variation, depending on its origin, mode of preparation, and its degree of purity. When the substance to be analysed is a mixture of similar substances with nearly the same number of carbon atoms in the molecules, the use of the interstice loses part of its analytical value.—**A. Henne** and **G. L. Clark**: The spectrography of flames in an explosion motor. Photographs were taken of the complete explosion and also of the four quarters of the explosion separately, with special reference to the phenomenon of knocking. The influence of the addition of such antidetonants as lead tetra-ethyl is to regularise the explosion in such a manner that the amount of energy liberated per unit of time varies only slightly throughout the course of the explosion.—**Nicolas Perrakis**: The specific heats of a sufficiently cooled non condensed phase. J. Perrin, from Eucken's experiments, arrived at the conclusion that all gases sufficiently cooled take the same molecular heat as the monatomic gases. The same conclusion is now obtained from simple theoretical considerations.—**Mme. Ramart-Lucas** and **Mlle. Amagat**: Molecular transpositions. The preparation and dehydration of some α-alkyl-α-phenylethanols.—**G. Darzens** and **A. Heinz**: *p*-Xylylallylacetic acid and its conversion into cyclic tetrahydronaphthalene derivatives. The preparation of a new dimethyl-naphthalene. This synthesis is carried out in the following stages: ethyl *p*-xylylmalonate, ethyl *p*-xylyl-allyl-malonate, dimethyltetrahydronaphthalene carboxylic acid, dimethylnaphthalene carboxylic acid, dimethyl-naphthalene.—**Itizo Kasiwagi**: The action of nitromethane and its homologues on benzil.—**G. Kempp**: The modification of a frequency curve brought about by the superposition of a sinusoidal variation with accidental variability. A mathematical discussion of the temperature variations at Spitsbergen.—**Pierre Lesage**: The persistence of precocious character (in plants) at different periods of the year.—**Henri Humbert**: Two types of unifacial structure of the leaf in Madagascan Senecio.—**G. Guittonneau**: The microbial oxidation of sulphur in the course of ammonia production from peptone.—**J. Sabrazes**: The spirochæte of yaws (*Spirochæta pertenuis*): its coloration.

Copenhagen.

Royal Danish Academy of Science and Letters, Nov. 11.—**O. B. Bøggild**: The meteoric iron block from Savik at Cape York. Occurrence and history; form and surface; composition of the interior; researches of the structure of the octahedrites.

Dec. 17.—**Niels Bohr**: Atomic theory and wave mechanics. The quantum theory of atomic constitution contains an essential element of discontinuity contrasting with the classical theories of mechanics and electrodynamics. In view of the recent promising results of the modification of classical mechanics known as the wave mechanics, the problem has arisen as to the possibility of avoiding any element of discontinuity in the description of atoms. This possibility, however, would seem excluded in the present state of science, where we meet with difficulties regarding fundamental concepts common for the classical theories and wave mechanics.

Geneva.

Physical and Natural History Society, Dec. 16.—**E. Briner**, **G. Lunge**, and **A. Mirimanoff**: The reaction of nitrogen peroxide with sulphurous anhydride. The reaction is $2SO_2 + 3NO_2 = S_2N_2O_9 + NO$. The substance $S_2N_2O_9$ was obtained by La Provostaye, who, however, supposed it to be formed by another process.—**E. Briner** and **O. Agathon**: On the combinations of the phenols with ammonia, and the formation of higher ammoniates. Besides the monoammoniates formed by the addition of one molecule of ammonia to the phenols, the authors found, in operating with higher pressures, a production of ammoniates containing several molecules of ammonia.—**A. Jayet**: The Albian of the Reposoir (Haute-Savoie).—**L. W. Collet** and **R. Perret**: A supplement to the geology of the Col d'Anterne and the Cirque des Fonts.—**E. Bujard**: Action of repeated injections of ovalbumin upon the testicle of the white rat. Lesions are produced similar to those produced by alcohol and iodine.—**E. Cherbuliez** and **R. Wahl**: The hydrofluoric hydrolysis of the proteids. This does not eliminate the formation of humic substances any more than does hydrochloric or sulphuric hydrolysis.—**A. Pictet**: Synthesis of lactose. Glucose is transformed into glucosane, and this into diglucosane. The latter is condensed with β-galactose, giving a lactose anhydride, which is then hydrolysed.—**E. Paréjas**: Bone deposit of the Doldenhorn. The fragments can be with certainty ascribed to a reptile.—**E. Paréjas**: New observations on the base of Mont Joly (Haute-Savoie). A correction of tectonic interpretation; the coal strata are triassic and not carboniferous.

Sydney.

Linnean Society of New South Wales, Nov. 24.—**Miss Lesley D. Hall**: The physiography and geography of the Hawkesbury River between Windsor and Wiseman's Ferry. A detailed description is given of the physiography of the main river and the lower portions of its tributaries. Man's dependence on physiographic factors is traced from the beginnings of settlement to the present day.—G. H. Hardy: A reclassification of the Australian robberflies of the Cerdistus-Neoitamus complex (Diptera-Asilidæ). The status of several genera, for which no scheme of classification hitherto evolved has met with general acceptance, is discussed. The generic name Cerdistus is adopted for the group, and under it Neoitamus, Cerdistus, and Stilpnogaster are ranked as subgenera, each of which is well represented in Australia.—A. H. S. Lucas: Notes on Australian marine algæ. (iii.) The Australian species of the genus Nitophyllum. *N. erosum* extends on the west coast so far north as the Houtman's Abrolhos, and *N. sinuosum* up to Port Stephens on the east coast, but the genus is only abundantly represented in the south, with its headquarters in Bass Straits, where multifarious forms occur which may be regarded as varieties or species.—M. Aurousseau: Analyses of three Australian rocks. Analyses are presented (*a*) of the well-known rock from One Tree Point, Sandy Bay, Hobart, Tasmania, a supposed fayalite basalt or melilite basalt, but actually a nephelite basanite; (*b*) of a micrographic granite from Ashford, N.S.W., that shows complicated graphic intergrowth; (*c*) of a peculiar amphibolite from Bunker Bay, Cape Naturaliste, W.A.—G. H. Cunningham: Gasteromycetes of Australasia. (vi.) The genus Lycoperdon. A critical revision of the members of the genus in Australia and New Zealand.

Official Publications Received.

British and Colonial.

Canada. Department of Mines: Mines Branch. Investigations in Ore Dressing and Metallurgy (Testing and Research Laboratories) 1925. (No. 670.) Pp ii+122+4 plates. Investigations in Ceramics and Road Materials (Testing and Research Laboratories) 1926. (No. 672.) Pp. 35. (Ottawa: F. A. Acland.)

The Quarterly Journal of the Geological Society. Edited by the Permanent Secretary. Vol. 82, Part 4, No. 328, December 31st. Pp. 469-677+xx+17 plates. (London: Longmans, Green and Co, Ltd.) 7s. 6d.

Aeronautical Research Committee: Reports and Memoranda No. 1041 (A. 8). Accidents to Aeroplanes involving Flutter of the Wings. Report of the Accidents Investigation Sub-Committee. (D.1. Special Technical Questions, 161.—T. 2168.) Pp 19+12 plates. 1s. 3d. net. No 1045 (E. 21): On the Equivalence between the Dynamical System of a Multi Crank Flywheel System and a certain Electrical Circuit, with some Suggestions for Measuring Critical Speeds and Shaft Stresses by Analogy. By E. B Moullin. (T.V.C.9.) Pp. 9. 9d. net. (London: H M. Stationery Office.)

City and County of Bristol: The Bristol Museum and Art Gallery. Report of the Museum and Art Gallery Committee for the Year ending 30th September 1926. Pp. 24+5 plates. (Bristol.)

Amgueddfa Genedlaethol Cymru: National Museum of Wales. Nineteenth Annual Report, 1925–26, presented by the Council to the Court of Governors on the 22nd October 1926. Pp 50+6 plates. (Cardiff) 6d.

County Borough of Reading: Museum of Economic Botany. Catalogue. Pp. 31. (Reading.)

The Journal of the Royal Horticultural Society. Edited by F. J Chittenden. Vol. 52, Part 1, January. Pp. 152+lxxvi+40 plates. (London.) 7s. 6d.

Scientific Proceedings of the Royal Dublin Society. Vol. 18 (N.S.), No. 29: Responses of Plant Tissues to Electric Currents. By Prof. H. H. Dixon and T. A. Bennet-Clark. Pp 351-372. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 2s.

The Journal of the East Africa and Uganda Natural History Society. No. 27, November. Pp. 197-245+plates 15-34 (Nairobi.) 10s.

Journal of the Chemical Society: containing Papers communicated to the Society. January. Pp. vi+iv+281. (London: Gurney and Jackson.)

Hull Museum Publications No 115: Record of Additions, No 70. Edited by T. Sheppard. Pp. 47. (Hull.)

Foreign.

Department of Commerce: U.S. Coast and Geodetic Survey, Terrestrial Magnetism. Serial No 358: Results of Magnetic Observations made by the United States Coast and Geodetic Survey in 1925 By Daniel L. Hazard. (Special Publication No. 126.) Pp. 87. (Washington, D.C.: Government Printing Office) 10 cents.

Department of the Interior: U.S. Geological Survey. Bulletin 785C: Borate Deposits in the Kramer District, Kern County, California By L. F. Noble. (Contributions to Economic Geology, 1926, Part 1) Pp. ii+45-61. Bulletin 785D: Note on a Colemanite Deposit near Shoshone, Calif.; with a Note on the Geology of a Part of Amargosa Valley. By L. F. Noble. (Contributions to Economic Geology, 1926, Part 1.) Pp. ii+63-75. Bulletin 786A: The Geology of the Ingomar Anticline, Treasure and Rosebud Counties, Montana. By K. C Heald. (Contributions to Economic Geology, 1926, Part 2.) Pp. iv+37+2 plates. (Washington, D.C.: Government Printing Office.)

New York Academy of Sciences Scientific Survey of Porto Rico and the Virgin Islands Vol. 8, Part 1: Botany of Porto Rico and the Virgin Islands Mycology. By Fred J Seaver and Carlos E Chardon; with Contributions by Rafael A. Toro, F. D. Kern and H. H. Whetzel, and L. O. Overholts. Pp 208. (New York City.) 2 dollars.

Department of the Interior: Bureau of Education. Bulletin, 1926, No. 9: Statistics of Public, Society and School Libraries, 1923. Pp. 179. (Washington, D.C.: Government Printing Office) 25 cents.

Department of Commerce: Bureau of Standards. Miscellaneous Publications. No. 74: Weights and Measures. Nineteenth National Conference of Representatives from various States held at the Bureau of Standards, Washington, D.C., May 25, 26, 27 and 28, 1926. Pp. xv+172+6 plates. (Washington, D.C.: Government Printing Office.) 60 cents.

Sveriges Geologiska Undersökning. Ser. C, No. 334, Årsbok 19 (1925), No. 1: Hydrologiska undersökningar av åkerjord inom Örebro län. Av Gunnar Ekström och Herman Flodkvist. Pp 48 1 kr. Ser. C, No. 335, Årsbok 19 (1925), No. 2: Södra Sveriges torvtillgångar, I. Av Lennart von Post och Erik Granlund Pp. 127+15 tavlor 8 kr. Ser C, No. 336, Årsbok 19 (1925), No. 3. On the Differentiation of the Alkalies in Aplites and Aplitic Granites By N. Sundius. Pp. 48. 1 kr. Ser. C, No 337, Årsbok 19 (1925), No. 4: Einige Aufgaben der regionalen Moorforschung. Von Lennart von Post. Pp 41. 1 kr. Ser. C, No. 338, Årsbok 19 (1925), No. 5: Mullmalmer i Svenska järngruvor. Av Per Geijer och Nils H. Magnusson With a Summary: The Occurrence of 'Soft Ores' in Swedish Iron Mines. Pp. 53+2 tavlor. 1 kr Ser. C, No. 339, Årsbok 19 (1925), No. 6: Ravinbildningen i Gustavs. Av Carl C von Caldenius. Pp. 26+3 tavlor. 1 kr. (Stockholm.)

Annual Report of the Board of Regents of the Smithsonian Institution, showing the Operations, Expenditures and Condition of the Institution for the Year ending June 30, 1925. (Publication 2836.) Pp. xii+633+84 plates (Washington, D.C.: Government Printing Office.) 1 50 dollars

Proceedings of the United States National Museum. Vol. 69, Art 18: Notes on the Age of the Continental Triassic Beds in North America, with Remarks on some Fossil Vertebrates. By F R. von Huene. (No. 2644) Pp 10. (Washington, D.C.: Government Printing Office)

State of Illinois. Department of Registration and Education: Division of the Natural History Survey. Bulletin, Vol. 16, Art. 3: Notes on Homoptera from Illinois, with Descriptions of New Forms, chiefly Eupteryginae. By W. L. McAtee. Pp. 127-136. (Urbana, Ill.)

U.S. Department of the Interior. Annual Report of the Commissioner of Education to the Secretary of the Interior for Fiscal Year ended June 30, 1926. Pp. iii+36. (Washington, D.C.: Government Printing Office.) 5 cents.

Catalogues.

Catalogue méthodique des livres de médecine. Pp. 96. (Paris: Masson et Cie.)

Electric Furnaces at the British Industries Fair, Birmingham. Pp. 6. (London: Automatic and Electric Furnaces, Ltd.)

Origin of Mankind: being a Catalogue of Books relating to Anthropology, Folklore, Ethnography, Archaeology, Occult, Heathenism, Witchcraft, Native Races, Mythology, Magic and sundry other Subjects concerning Man. (No. 491.) Pp. 68. (London: Francis Edwards.)

Neue Bücher. Januar. Pp. 47. (Berlin: Julius Springer)

Diary of Societies.

SATURDAY, February 12.

Royal Institution of Great Britain, at 3.—W. de la Mare: 'Atmosphere' in Fiction.

Mining Institute of Scotland (at Edinburgh)

MONDAY, February 14.

Royal College of Surgeons of England, at 4.—Sir Berkeley Moynihan, Bart.: Hunterian Oration.

Royal Irish Academy, at 4.15.

Royal Society of Edinburgh, at 4.30.—Dr R. T Gunther: Certain Early Astronomical Instruments and their Makers, illustrated by the Exhibition of Instruments in the possession of the University of St. Andrews and by lantern slides (Address).—Sir J. R Findlay: Exhibition and Description of certain Instruments from his Private Collection.

Royal Geographical Society (at Lowther Lodge), at 5.—Lt.-Comdr. R. Gould: The Landfall of Columbus.

Institution of Automobile Engineers (Birmingham Centre) (at Chamber of Commerce, Birmingham), at 7.—H. W. Sisman: The Straight-Eight Engine.

Institution of Electrical Engineers (North-Eastern Centre) (at Sopwith's Café, Newcastle-upon-Tyne), at 7.—Informal Discussion on The Problem of Rural Supplies.

Institution of Electrical Engineers (Western Centre) (at South Wales Institute of Engineers, Cardiff), at 7.—W. M. Selvey: Power Stations and their Equipment (Lecture).

Institute of Metals (Scottish Local Section) (at 39 Elmbank Crescent, Glasgow), at 7.30.—D. R. Tullis: Notes on Aluminium Alloys.

Aristotelian Society (at University of London Club), at 8.—Prof. R. F. A. Hoernle: Problems and Methods of Metaphysics.

Royal Society of Arts, at 8.—Prof. E. G. Coker: Photo-elastic Measurements of Stress Distribution (Cantor Lectures) (1).

Institute of Chemistry (Edinburgh and East of Scotland Section) (jointly with Society of Chemistry, Edinburgh and East of Scotland Section) (at 36 York Place, Edinburgh), at 8.—B. D. W. Luff: The Use of the Microscope in Qualitative Analysis.

British Psychological Society (Education Section) (at London Day Training College), at 6.—Dr. Cloudesley Brereton: The Philosophical Basis of the Teaching of Literary Appreciation.

Cambridge Philosophical Society (in Botany School, Cambridge), at 4.45.—Prof. H. L. Hawkins: Some Problems in the Evolution of the Echinoidea.

Institute of Chemistry (Manchester and District Section).—Prof. R. Robinson: Electronic Theories of Valency in Organic Chemistry.

TUESDAY, February 15.

Electrical Association for Women (at King's College for Women (Household and Social Science Department), Campden Hill Road), at 5.15.—Mrs. C. Frederick: How the American Housewife solves her Household Difficulties.

Royal Statistical Society (at Royal Society of Arts), at 5.15.—G. H. Wood: An Examination of some Statistics relating to the Wool Textile Industry.

Royal Society of Medicine, at 5.30.—General Meeting.

Royal Sanitary Institute, at 5.30.—Dr. W. Robertson and others: Discussion on Immunisation against Diphtheria.

Royal Aeronautical Society, at 6.—W. H. Dyson and others: Informal Discussion on Materials, with special reference to Corrosion.

Child-Study Society (at Caxton Hall), at 6.—Hon. Bertrand Russell: Nursery Schools

London Natural History Society (at Winchester House, E.C.), at 6.30.—H. Spooner: The Natural Regeneration of Woodlands.—R. W. Hale: The Little Owl.

Society of Chemical Industry (Glasgow Section) (jointly with Institution of the Rubber Industry) (at 39 Elmbank Crescent, Glasgow), at 7.—R. D. Porritt: The Milling of Rubber.—T. R. Dawson: The Hardness Testing of Vulcanised Rubber.—J. T. Strachan: Demonstration of a New Piezo-micrometer.

Royal Photographic Society of Great Britain, at 7.—J. C. Dollman: Good Taste, Bad Taste, and No Taste at all.

Institution of Automobile Engineers (Wolverhampton Centre) (at Engineering and Scientific Club, Birmingham), at 7.30.—A. H. R. Fedden: The Supercharging of Aircraft and Motor Vehicle Engines.

British Institute of Philosophical Studies.—Prof. J. S. Huxley and Dr. M. Ginsberg: The Claims of Eugenics.

WEDNESDAY, February 16.

Society of Glass Technology (jointly with Yorkshire Section of Society of Chemical Industry) (at Sheffield University), at 2.30.—General Discussion on Silicate Analysis:—W. H. Withey: A Critical Survey of Methods for the Analysis of the Simpler Glasses.—Violet Dimbleby: Notes on Methods Used in the Analysis of Glasses.—W. J. Rees: The Analysis of Refractories.—T. P. Colclough: Notes on the Analysis of Silicate Slags.

Royal Society of Medicine (History of Medicine Section), at 5.—Prof. J. F. Dobson: Erasistratus.—W. R. Dawson: Contribution to the History of Mummification.—Dr. C. Singer: An Example of the Egyptian God Bes Exhibiting Symptoms of Spina Bifida.

Royal College of Surgeons of England, at 5.—Prof. E. M. Cowell: Recent Advances in the Surgery of Hernia.

Royal Institution of Great Britain, at 5.15.—Prof. J. S. Huxley: Problems of Animal Growth and Development (3).

Institution of Civil Engineers (Students' Meeting), at 6.30.—R. F. Legget: Some Considerations of our Power Resources.

Institution of Automobile Engineers (Manchester Centre) (at Engineers' Club, Manchester), at 7.—E. W. Sisman: The Straight-Eight Engine.

Institution of Electrical Engineers (Mersey and North Wales (Liverpool) Centre) (jointly with Liverpool Engineering Society) (at The Temple, Dale Street, Liverpool), at 7.

Institution of Electrical Engineers (South Midland Centre) (at Birmingham University), at 7.—P. Dunsheath: 33,000-Volt Cables with Metal-Sheathed Cores, with special reference to the S. L. Type.

North-East Coast Institution of Engineers and Shipbuilders (Graduate Section) (at Bolbec Hall, Newcastle-upon-Tyne), at 7.15.—E. Hinchliffe: The Experiment Tank in Ship Design.

Institution of Electrical Engineers (Sheffield Sub-Centre) (jointly with Institute of Metals—Sheffield Local Section) (at Sheffield University), at 7.30.—Dr. V. E. Pullin: The Application of X-Rays to the Examination of Metals (Lecture).

Eugenics Society (at Hotel Rembrandt), at 7.30.—Dr. A. F. Tredgold: Mental Disorder in relation to Eugenics (Galton Lecture).

Merseyside Aquarium Society (at Liverpool Museum), at 7.30.

Royal Meteorological Society, at 7.30.—Dr. J. Glasspoole: The Variability of Average Monthly Rainfall throughout the Year.—Dr. L. F. Richardson and D. Proctor: Diffusion over Distances ranging from 3 km. to 86 km.

Royal Society of Arts, at 8.—C. C. Paterson: Some Studies in Electric Lamps and Valves.

Folk-Lore Society (Annual Meeting) (at University College), at 8.—Presidential Address.

Royal Microscopical Society, at 8.—Dr. W. E. Cooke: The Life History of the Neutrophil Polymorphonuclear Leucocyte.—Dr. A. S. Parkes, Dr. F. W. R. Brambell, and F. Melville: The Effect of X-Ray Sterilisation on the Development of the Accessory Organs of Reproduction in the Mouse.

Institute of Chemistry (London Section).

Royal Medico-Psychological Association (at Cheshire County Mental Hospital, Parkside, Macclesfield).—Prof. T. H. Pear: Recent Investigations on Visual Imagery, with special reference to Hallucinations.

THURSDAY, February 17.

Royal Society, at 4.30.—G. U. Yule: Wolfer's Sunspot Numbers considered as a Disturbed Periodic Series.—Dr. G. M. B. Dobson and D. N. Harrison: Measurements of Ozone in the Earth's Atmosphere and its Relations to other Geophysical Conditions—Part II.—H. Horrocks: Meteorological Perturbations of Tides and Currents in an Unlimited Channel Rotating with the Earth.—*To be read in title only:*—Prof. H. Levy and A. G. Forsdyke: The Stability of the Vortex System in the Rear of a Moving Body.—A. Fage: The Flow of Air and of an Inviscid Fluid around an Elliptic Cylinder and an Aerofoil of Infinite Span.

Royal Institution of Great Britain, at 5.15.—Sir William Bragg: Acoustical Problems treated by Lord Rayleigh (3): Bells.

Child-Study Society (at Royal Sanitary Institute), at 6.—S. Marks: The Educational Aspect of the Model Theatre.

Institution of Electrical Engineers, at 6.—F. H. Clough: The Stability of Large Power Systems.

Royal Aeronautical Society (at Royal Society of Arts), at 6.30.—Major R. H. Mayo: The Design and Operation of Commercial Aircraft.

Chemical Society, at 8.—H. O. Askew: The Production of Fog in the Neutralisation of Alkali with Hydrogen Halides.—F. H. McDowell: Constituents of Myoporum Laetum Forst. (The "Ngaio.") Part II. Hydrogenation of Ngaione and Ngaiol, and Dehydration of Ngaiol.

Royal Society of Tropical Medicine and Hygiene (at 11 Chandos Street, W.), at 8.15.—Lt.-Col. W. P. MacArthur: Old-Time Typhus in Britain.

Institution of Mechanical Engineers (Manchester Meeting).

Institution of the Rubber Industry (Manchester Section) (at Liverpool).—H. C. Young: Production Methods in a Rubber Factory.

FRIDAY, February 18.

Geological Society of London, at 3.—Annual General Meeting.

Royal Astronomical Society (Geophysical Discussion), at 5.—Dr. Vaughan Cornish: The Propulsion of Waves in Granular Material by Winds and Currents. Other speakers, Dr. T. E. Stanton, Dr. H. Jeffreys. Chairman, Sir Frank Dyson.

Royal College of Surgeons of England, at 5.—Prof. A. H. Southam: The Pathology and Treatment of the Retained Testis in Childhood.

Society of Chemical Industry (Liverpool Section) (at Liverpool University), at 6.—Col. Sir Frederick L. Nathan: Fuels for Internal Combustion Engines.

Institution of Mechanical Engineers, at 6.—Annual General Meeting.

Society of Chemical Industry (Glasgow Section) (at 39 Elmbank Crescent, Glasgow), at 7.—Fuel Lecture.

Electrical Association for Women (at E.L.M.A. Lighting Service Bureau, Strand), at 7.—Mrs. C. Frederick: Household Engineering and Efficiency Tests.

Photomicrographic Society (at 4 Fetter Lane), at 7.—Members' Evening.

Royal Photographic Society of Great Britain (Pictorial Group), at 7.—A. L. Eavestaff: The Graphic Eye and the Photographic Eye.

Junior Institution of Engineers, at 7.30.—L. Turner: Modern Concrete Construction: A Review of Recent Progress and Problems.

Royal Institution of Great Britain, at 9.—Sir Josiah C. Stamp: The Laws of Monetary Science.

SATURDAY, February 19.

North of England Institute of Mining and Mechanical Engineers, at 2.30.

Royal Institution of Great Britain, at 3.—W. de la Mare: The Supernatural in Fiction.

Oxford University Junior Scientific Club (Exhibition Meeting), at 8.15.

Physiological Society (at St. Thomas's Hospital).

PUBLIC LECTURES.

SATURDAY, February 12.

Horniman Museum (Forest Hill), at 3.30.—Miss M. Edith Durham: Some Old Montenegrin Customs.

SUNDAY, February 13.

Guildhouse (Eccleston Square), at 3.30.—N. C. Sen: Brahmo Somaj.

MONDAY, February 14.

London School of Economics, at 5.—Prof. P. Geyl: Dutch Society and Dutch Politics in Spinoza's Time.

St. Thomas's Hospital (Sherrington School of Physiology), at 5.—Prof. W. Storm van Leeuwen: Allergic Diseases caused by Factors of Climate. (Succeeding Lectures on February 15 and 16.)

King's College for Women (Household and Social Science Department), at 5.15.—Prof. J. Garstang: The Songs of Birds.

TUESDAY, February 15.

Bedford College for Women, at 5.15.—Sir Frank W. Dyson: Conceptions of the Cosmos from the Times of Copernicus to Galileo.

King's College, at 5.30.—C. E. M. Joad: Vitalism and Theory of Knowledge.

WEDNESDAY, February 16.

Birkbeck College, at 5.45.—Major R. F. Wall: The Care of Domestic Animals. (Succeeding Lectures on February 23 and March 2.)

THURSDAY, February 17.

Imperial College of Science and Technology, at 5.30.—Prof. G. H. Hardy: Trigonometrical Series. (Succeeding Lectures on February 24 and March 3.)

King's College, at 5.30.—Rev. Dr. W. R. Matthews: The Mind: Philosophy.

University College, at 5.30.—Dr. E. Deller: 'The University Idea' in the United States.—Prof. E. A. Stensiö: The Ostracoderms, their Organisation and Relationships. (Succeeding Lectures on February 18, 22, and 24.)

Northampton Polytechnic Institute, at 7.—R. Genders: Steel and its Thermal Treatment (6): Cast and Malleable Cast Iron.

SATURDAY, February 19.

Horniman Museum (Forest Hill), at 3.30.—Dr. W. T. Calman: The Shipworm, a Pest of the Seas.

SUNDAY, February 20.

Guildhouse (Eccleston Square), at 3.30.—C. Bailey: The Religious Experiences of Ancient Rome.

SATURDAY, FEBRUARY 19, 1927.

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The Preservation of Nature.

PUBLIC opinion is inclined to look upon the scenery and great natural monuments of a country as of the order that lasts for aye, and to imagine that their survival through many millennia betokens an infinite future. It little realises that in this and other civilised countries, human progress is constantly nibbling at the works of Nature, and that greatly as the rate of consumption has grown in recent years, the threat will undoubtedly be magnified in the years to come. The need of water-supplies for the centres of population has altered lakes and swamped valleys; the demands of industry have changed rivers and harnessed waterfalls; the vast requirements of the modern metalling of roads are cutting into the 'everlasting' hills; and the desire for speedy transport has driven and threatened to drive bleak roads through some of the select scenery of the land.

With all this there has been, of course, immense economic gain, but there has also been loss. There has been a loss of beauty, a destruction of things of æsthetic and artistic appeal; and who knows what unconscious influence these may have [illegible] had upon the minds of men? But there has also been a loss to science, sometimes material, more often of those historic-sentimental records, which, linking the achievements of the past with present-day knowledge, stir the imagination and stimulate the broad view. The haunts of a dwindling native flora and fauna are being disturbed: the driving of a road (abetted by the importunities of collectors) banished the Artaxerxes butterfly from its first discovered site in the King's Park, Edinburgh, which had "stocked the cabinets of Europe." Just as in Italy the Barma Cave, the richest and most interesting of the Grimaldi caves, which have added so greatly to the knowledge of palæolithic man, has been exploited for building stone, so the M'Arthur Cave at Oban, the first recognised habitation of Azilian man and, until the discoveries of last summer, the oldest known human dwelling in Scotland, has been entirely quarried away. The historic rock on Blackford Hill within Edinburgh, on the smoothed surface of which Agassiz first detected indubitable traces of an ice age, is threatened by the road-metal excavations of Midlothian County Council, and similar operations in Haddingtonshire will eat into Traprain Law, the site of extensive Celtic settlements and of the discovery of a unique silver hoard belonging to an early century of our era.

Here is a clash between 'business' on one hand

and æsthetics and science on the other. Obviously so disintegrating a warfare ought to be stopped, but how? Not by a simple attitude of protest, for the claims of 'business' cannot be lightly brushed aside, and the county council 'steam-roller' has an effective way of overriding objections. A burst of local effort endeavours to meet each new aggression, and occasionally a treasure is saved. Stybarrow and Glencoin Woods in Ullswater have thus been rescued within the last few weeks, and the *Times* of Feb. 5 announced that negotiations were understood to have reached a successful issue "whereby the land on the west side of the Borrowdale road, from Peterfield to the entrance to Stable Hills Farm, will be saved from all possibility of being built on, and the uninterrupted view over Derwent Water into the famous 'jaws' of Borrowdale and across to Cat Bells will be preserved intact for all time." In both cases appeal is made for public subscriptions of considerable amounts, necessary if successful negotiations are to be converted into the full goal of permanent preservation.

More often, however, the 'steam-roller,' if checked at all, is only temporarily checked and soon returns to complete its work. A year or two ago the danger seemed to have been turned from Traprain Law, but now preparations for extensive quarrying on part of the hill are in full swing. On the whole, local effort is too little organised, too spasmodic, too late in getting into action, too lacking in persistence and in authority to deal efficiently with such emergencies.

The needs of industrial progress are clamant and cannot be gainsaid by a point-blank negative, but is there no room for compromise? Compromise implies give and take on both sides; what has the æsthetic and scientific side to bargain with? As the law of Britain stands, it has nothing; for though more than twenty years ago France passed its first law towards the protection of 'sites pittoresques,' in Great Britain public opinion remains the only support. The matter seems to rest upon the nature of property in land; does purchase or possession imply for the possessor an absolute right to deal anyhow with the land he possesses? We act as if possession held this absolute right, and as if only by special appeal or through special favour may the right be waived; but ideas are changing and have changed. The absolute right no longer holds in the great cities, where an owner may not build upon his land except in accordance with the interests of the community as expressed by the Dean of Guild Court or some similar body.

The time will come when a natural monumen whether its message be æsthetic, historic, scientific, will be reckoned of as much value a garage, and its preservation or destruction matter not for the individual but for the nation.

Other countries, recognising their value in th national life, have moved or are moving toward a general conservation of the natural sites an monuments of artistic, scientific, historic, an legendary interest. A vast body of evidence i this sense was submitted to the "Congrès inter national pour la Protection de la Nature" held i Paris in the summer of 1923, and appears i the "Rapports, vœux et réalisations" of th Congress published in 1925. In 1906 the *lo Beauquier*, which provided for the classification o picturesque sites, particularly forest areas, by special commission in each department, and for th safeguarding of these places, set the ball rolling i France. Since then various measures of preservation have been applied to the colonies of France b decrees of the colonial minister. In Switzerland Spain, Poland, Jugoslavia, Hungary, and Russi the movement is strongly supported. In Grea Britain spasmodic efforts have become crystallise in the Royal Society for the Promotion of Natur Reserves in the British Isles, and it has alread done good work. We trust, however, that the lac of faith in the efficacy of parliaments and governments as protectors of the beautiful and interesting expressed at the Paris conference by the president Viscount Ullswater, does not mean that this influential society will refrain from impressing upo the government of the day the desirability of safeguarding natural monuments, until parliamentar recognition gives a national sanction far mor effective than that of any private organisatio could be.

If, as we assume, a method of compromis between industrial needs and the demand for th picturesque or significant will ultimately replac the spasmodic and point-blank opposition of th present, who is to arrange the compromise? It must be a body with authority, with knowledge, and with sympathies broad enough to gain the confidence of both sides. Local authorities are already sufficiently burdened with duties, and their very proximity may be apt to obscure the broad view.

In France the Government appointed a special commission for the precise purpose, and this would seem to be the most satisfactory method. We need a Nature Monuments Commission, an advisory body attached to one of the great departments o

State, with the needful statutory backing. This body, with such local help as could be obtained, might draw up lists of Nature monuments and haunts of rare animals and plants deserving of preservation, but a chief function would be to receive from recognised local bodies complaints of threatened destruction, and to decide whether the particular needs of economic development were such as to demand the sacrifice of a national asset, or whether some adjustment might be arranged so that whole or part of the threatened natural monument might be preserved.

Until recent years the handiworks of prehistoric man and his successors existed in Great Britain unprotected from the elements or from the despoiler (except where private ownership bestirred itself), and, as a consequence, hundreds of stone circles of the bronze age and prehistoric sepulchral cairns, as well as buildings of Roman or later times, have been demolished and converted into stone dykes and insignificant barns, byres, and cottages. But the creation by government of an Ancient Monuments Commission has saved the situation, and invaluable work has been done by this body in scheduling and protecting the irreplaceable relics of the former inhabitants of Britain. Here is a precedent for the creation of a Nature Monuments Commission, and here in many ways is a model for its labours.

James Ritchie.

The Chemistry of Rhythmic Actions.

The Problem of Physico-Chemical Periodicity. By Dr. E. S. Hedges and Dr. J. E. Myers. Pp. 95+2 plates. (London: Edward Arnold and Co., 1926.) 7*s.* 6*d.* net.

The normal chemist is so well used to seeing his reagents pass away in a decently continuous fashion, that when he finds them attacking each other in a succession of recurrent spasms, he is a little apt to shy off. The thing is, perhaps, too nearly suggestive of heart-beats, of vital processes, and of human activities: domains into which chemists are warier of intruding than formerly, and which they prefer to leave to their bolder brethren, the physiologists and the historians. At all events, rhythmic, pulsating, or periodic reactions have seldom been systematically followed up in any general way by chemists. There have been, it is true, such detailed inquiries as Ostwald's on the periodic dissolution of a specimen of chromium in acid, as Bredig's on the pulsating decomposition of hydrogen peroxide by mercury, and as the numerous studies of the Liesegang effect in jellies; but Dr. Hedges and Dr. Myers have now worked their way to a more comprehensive survey than these, which they have summarised in a small monograph. The broad plan of this is, first to classify periodicities of various sorts, then to set forth the experimental factors that operate in each class, and to give in the end an indication of the views which the authors—themselves notable experimenters in the field—have formed as to underlying causes. The full and important bibliographic index contains about 300 references, of which about one-third centre in the Liesegang phenomenon. About twenty fall outside the last thirty years.

The kinds of periodicity discussed are shown by the authors' definition of the word: "the recurrence of some property or accentuation of a property at regular intervals of time, distance, or other quantity." The sub-atomic recurrences that give rise to periodicities such as Mendeléeff's are intentionally excluded. Three main classes may be distinguished. In one, the speed of a chemical reaction shows pulsations, time being here the variable; in another are the reactions or properties in which space is the variable, so that fixed space-patterns are formed, like the layers in an agate; and in another class the variable to which the pulses in properties are referred is not obviously time or space, but some adjustable condition such as degree of dilution or extent of mechanical stress.

One example of the third class is Holker's effect, in which a row of tubes of a colloid solution show alternating groups of 'thick and clear' when each tube is given a stronger dose of electrolyte than its left-hand neighbour had. Another example placed in this category (labelled "static periodicity") is found in the waxings and wanings of the mechanical and other qualities of some metals when subjected to continued cold-working.

The second class includes all the phenomena first studied thirty years ago by Liesegang: the stratification caused by the advance of a reagent into a jelly containing a second reagent. The valuable critical survey of the work in this class shows that although stratification is favoured by the presence of jellies, these are not essential to it. It can, for example, occur by the slow merging of gaseous ammonia and hydrogen chloride; yet even here it is to be noted that the smoke produced is a colloid, and so are the glass reaction-tubes. It is obvious, in all cases, that a prime necessity is that diffusion must be going on, and to that extent time-rates must come into the affair; but the authors say that there is nothing to suggest that the reaction-time curve itself is periodic. They are inclined to correlate the formation of Liesegang striæ with Holker's effect, already mentioned. Though much diverse work has been done, there is evidently much still to do before a full understanding is reached of the Liesegang phenomenon and, with it, of many structures that concern mineralogists and biochemists. The authors' survey will be very helpful to workers in this field.

The account of the work on periodic reaction-speeds, together with that on pulsating electrode-potentials, covers very interesting ground. Here the authors, in their own investigations, met what they call "the bugbear of work on periodic phenomena"; namely, the operation of essential but unidentified factors. This has led many other workers into puzzles and controversy; but Drs. Hedges and Myers' happy gift of devising crucial experiments has often enabled them to exclude irrelevant factors and to study the phenomenon at its simplest. For example, aluminium dissolving in alkali gives off hydrogen in pulses; is this merely due to the formation and subsequent discharge of supersaturated solutions of the gas, either in the metal or in the liquid? They make the aluminium one electrode of a cell containing the alkali; when it is made the anode, it dissolves and the hydrogen comes off in pulses—but at the other electrode; and when the aluminium is made the cathode, so that it does not dissolve, hydrogen is evolved from it—but smoothly. Hence the question is negatived. Again, it was found that certain cases of dissolution owed their periodicity to something in the glass walls of the containing vessel; and when the glass eventually 'tired,' periodicity could be restored by minute traces of various colloids. Eventually, the very important conclusion next mentioned was reached.

The core of the book is this: the authors show fairly conclusively that intermittent pulsations in a reaction $A+B$ are due to the presence of some substance, C, which must be in a certain special physical condition. This substance may be foreign to the net reaction; for example, metallic mercury will cause the spasmodic decomposition of hydrogen peroxide; but alternatively it may be one of the reagents themselves, appropriately treated beforehand. To mention one case, the dissolution of copper in a suitable acid goes by pulses if certain freshly made colloids are present, or alternatively if the copper itself has first been submitted to mechanical stress. The soft crystalline metals like lead and tin are not able to be activated for periodicity by being strained; the authors connect this with the faculty for self-annealing. With metals which have been only mildly strained, the property is apt to fade. Liquid mercury needs no special treatment; it is active without it.

What clearly emerges is that the seat of pulsation in a heterogeneous action is at an interface. Further, there are good reasons for suspecting that, despite some seemingly contrary evidence, no pulsating reaction is other than heterogeneous.

Drs. Hedges and Myers accordingly seek to go further; and, tentatively but suggestively, they refer rhythmic reactions, and rhythmic structures also, to effects of varying surface tension. There is evidence that this property, which itself affects reaction-speeds in a solution, can be a periodic function of the strength of a solution; and a valuable step forward will have been made if pulses in surface tension can be correlated with reaction pulses on one hand and with the Holker effect (and through it with the Liesegang phenomenon) on the other.

It still remains to explain why periodicity of any sort should occur at these surfaces. The evident connexion with catalytic action is commented on by the authors; but they seem to think that rhythmic movements of energy may be intrinsic in 'metastable' surfaces. It is quite possible, they say, that all catalysis is periodic in character, though only rarely measurably so. Many readers will probably argue that the factors which must, in that event, be invoked to explain the suppression of rhythm in innumerable observed cases, might just as well be used instead to explain its presence in a few. That is, we would make rhythm a result of superposed velocities, rather than stop short at a 'principle of periodicity.' Thus the reaction velocity in a volume of dilute reagents subject to catalysis at fixed surfaces in it will show pulsations, provided that the catalytic activity of the surface gradually increases until it causes a local 'explosion,' *i.e.* a reaction speed that outstrips the rate at which reagents reach the catalysing surface. An example is seen in the lecture experiment, wherein a heated platinum wire is hung above warm ammonia solution through which oxygen passes; the rhythm of accelerating catalysis culminating in explosion, with local exhaustion of the reagents and the renewal of the cycle, can be watched recurring for a long time. The molecular film-patch mechanism of surface catalysis, worked out by Langmuir and others, seems capable of describing conditions for such cases.

At the same time it is attractive to look upon a pulse inductor as a kind of bank of energy, as the fly-wheel of an engine; for it does behave as if it stored up energy gained from the reaction, delivering it again so as to stimulate the adjacent reaction when this would otherwise have slowed down. In this light we may survey Drs. Hedges and Myers' conclusions as to the physical texture needful in a pulse inductor. Collating their facts as to cold-worked metals and colloids, they believe that a metastable, amorphous form is essential. They do not clearly differentiate metastability from amorphism; definitely crystalline, but metastable, allotropic forms of metals do not happen to be mentioned as pulse inductors; but the case of liquid mercury acting in this way shows that the potential energy, which characterises a metastable variety, need not have been implanted in the substance by previous treatment, but may be gained from the reagents into which it is put. The factor common to pulse inductors might be crudely described as the ability to produce atoms the valency-bonds of which stick out of the substance. Thus it can be said that a pulse inductor deals out to the adjacent molecules some of its internal energy, derived from external sources and set free by the return of its own atoms to a more stable orientation.

An illuminating example of this 'relaxation' is quoted on p. 65; cold-worked copper spontaneously 'breathes' oxygen in and out for a long time; whereas stable copper under the same conditions scarcely takes up oxygen at all. One may perhaps be allowed to picture this, however imperfectly, as a slow union of oxygen with areas of active or abnormal atoms of the copper; when the film of oxide molecules has spread to the edge of a patch of normal copper atoms, the transition sets in rapidly at the boundary, which thus quickly invades the oxide film and causes the expiration of oxygen, demanded by the smaller affinity between oxygen and normal copper. A moderately quick renewal, from within the copper, of areas of active atoms would then make the cycle set in again; such renewal requires that energy shall be supplied to the copper from outside, either by previous cold-working, or else by the storage of energy evolved from the stoppage and fixation of gaseous oxygen upon the active atoms. A fairly good analogue is that of a sink, filled by a slow tap and intermittently emptied by a quick-acting siphon; gravitational energy here takes the place of chemical energy. (It would be interesting to know whether the oxygen expired in pulses from copper is chemically active, as hydrogen escaping from palladium, and other molecules newly released from combination, appear to be.)

The storage of energy here ascribed to pulse inductors, as it were in a delay-action fuze, may be compared with the similar storage of radiated energy that is seen within silica or fluorite when these are heated after being exposed to high-frequency rays; or, a better parallel here, in the photographic plate between exposure and development. (In passing, the 'reversed image' of a photographic plate suggests a periodic action.) Thus the time of relaxation can be long in a solid aggregate of molecules while no reagent is attacking the aggregate. In homogeneous systems, on the other hand, it is known from fluorescence measurements that the time of relaxation of the isolated molecules is extremely short; they do not appreciably store up energy, and accordingly, as has been mentioned, measurably pulsating reactions in truly homogeneous systems are suspected by Drs. Hedges and Myers not to occur.

These reflections are offered merely as a footnote to a work which gives an admirable experimental survey and classification of facts, new and old, that were in much need of being marshalled and brought to our notice. The book is bound to meet with a well-deserved success; and not among chemists only; the authors remind their readers that periodic phenomena are of high importance biologically. Physiologists, no less than physical chemists, will find here much to think about, even though the book describes no biochemical or biophysical researches; for a good deal in the rhythmic behaviour of the fibres of living tissue is surely connected with the factors that Dr. Hedges and Dr. Myers have found significant in their studies of unorganised materials.

Irvine Masson.

The Physiology of Growth.

The Fundamentals of School Health. By Dr. James Kerr. Pp. xvi + 859. (London: George Allen and Unwin, Ltd., 1926.) 35*s.* net.

"Local Education Authorities would be wise not only to facilitate and encourage investigation into local medical problems by members of their medical staff, but actually to expect and indeed require it. The problems are not only manifold but strangely significant and pregnant.

"For here is an expanding physiology, unexplored; here are the very beginnings of disease; here its cause may be searched with some hope; here it may often be prevented; here the physique and education of a nation are in rudimentary form —and whatsoever here be found by searching or proved by experiment becomes forthwith of value to the child, to the community, and to the growth of human knowledge."

In these words Sir George Newman, in his eighteenth annual report as chief medical officer of the Board of Education, just issued, points out the immense field of research into the physiology of growth which is offered by the presence in the nation's schools of the whole of the population during the most interesting and important years of development. Although there is now completely established a school medical service throughout Great Britain, with one whole-time school medical officer to 8500 children, but little has been done even to explore this abundant field. Local Education Authorities, frankly, are not interested in the question of research. Their medical staffs are overburdened with difficult problems of administration, and mere doctoring more than absorbs the whole of their available time.

The appearance of Dr. Kerr's book on "The Fundamentals of School Health" is therefore especially to be welcomed. Dr. Kerr has been exceptionally situated. Appointed thirty years ago as medical adviser to the most progressive of the provincial education authorities, he was in 1902 appointed medical officer to the London School Board. He was the first medical man in England to appreciate the importance of the subject he deals with, and was the first doctor to make a practice of daily visiting the schools. In 1911 the London County Council, recognising his unique qualifications, created for him the post of Research Medical Officer and, to give him full scope and opportunity, relieved him of all administrative cares.

The result of the research of a lifetime is to be found in this very remarkable book, with which there is none other in the English tongue that can be compared. It stands alone, and must for many a day stand, as an incomparable authoritative work.

Roughly, the forty-three chapters can be grouped into six logical divisions. First come five chapters which deal with heredity and growth, then twelve chapters dealing with general physical defects of the child, followed by five chapters dealing with mental development and intelligence; then eleven chapters directed to the physiology of the special senses, next five chapters dealing chiefly with problems of administration; and, finally, five chapters on the school environmental conditions of the child, including ventilation, heating, and illumination. It is impossible to do justice in a review to the care and labour which have gone to the making of this book. It is safe to say that it includes everything that has hitherto been learnt in regard to the subject, and much is founded upon original work carried out by Dr. Kerr or under his direction.

Of especial value are the chapters on the physiology of vision, upon ventilation, and upon illumination, but perhaps the most interesting are the early chapters dealing with problems of growth. Every one will agree with Dr. Kerr's denunciation of the general practice of treating averages as standards. One feels, however, that the author rather stresses environmental at the expense of genetic influences. Most of us would place the standard of height, for example, "somewhere between the Polish Count and Giant O'Brien," and for girth, "somewhere between the *Anatomie Vivante* and Daniel Lambert." Not so, Dr. Kerr; he is for Giant O'Brien every time. For Anglo-Saxon standards he draws arbitrarily a curve which is higher than the average attained by any but very exceptional groups. "They would represent the ideal young Anglo-Saxon as 6 feet high and weighing 11½ to 12 stones." Any one of our race failing to reach this standard would be considered by the author as having been stunted by environmental conditions. He adduces in support the measurements of the rowing members of Oxford and Cambridge University boat crews But surely a race is viewed as a congeries of genes, each of which, in respect to a character such as height, has its own maximum standard of attainment, and there must be innumerable Anglo-Saxon strains in which a height falling short of 6 feet by several inches is normal and not dependent upon environment. Do not they also serve who only sit and 'cox'?

Such criticism as this is not, however, to detract from the value of the book, but to point out the absorbing interest of the subject matter and its originality of presentment. The strong idealism of the author is shown in the tendency to stress environmental conditions. This idealism also causes him to leave the dusty road at frequent intervals in order to tilt at windmills—political, economic and administrative. He returns, however, to the straight path after every such adventure with renewed zest and ardour. While these excursions do not advance the author's theme, they serve to make the work extraordinarily interesting to read and to enliven a subject which might easily, by conventional presentation, have resulted in a dry as-dust disquisition.

It remains to say that, as befits the subject matte of the book, the type and format are unexceptionable, the illustrations and diagrams are numerous, and the tables clear and illuminative. While the work becomes immediately invaluable to all engaged in the problems of the care of the nation's childhood, it must remain to all time a classic.

Problems of Potato-Breeding.

Potato Varieties. By Dr. Redcliffe N. Salaman. Pp. xxii + 378 + 10 plates. (Cambridge: At the University Press, 1926.) 25*s*. net.

As the author says, the title of this book is noncommittal, but almost unreasonably so, for in addition to most exhaustive descriptions of all the commercial varieties, this treatise contains a very complete discussion of the various scientific problems connected with the origin, breeding, and cultivation of what the daily journalist delights in describing as the "comestible tuber."

Originally occupied in physiological research, Dr. Salaman has devoted the last twenty years to 'cultivating his garden' (and to some purpose), but the loss to medicine has proved a gain to agriculture. The diseases of the potato alone provide a fascinating subject for research, all the more seeing that the potato keeps up-to-date by falling a victim to virus diseases furnished with all the modern terrors of 'carriers' and environmental 'factors.' Of these diseases Dr. Salaman says: "By directly threatening one of the most important elements of the food of the people they become a question of national concern and their investigation a matter which no country can afford to neglect"—least of all, we may add, Scotland, for the trade in Scotch seed potatoes is one of the most important that the country enjoys. We are bound to notice the author's footnote. "The Ministry of Agriculture has devoted in all but a few hundred pounds to the elucidation of a disease the ravages of which are costing the country *at least five millions annually.*"

These insidious diseases, we learn, are known popularly by such names as 'curl,' 'crinkle,' 'mosaic'—epithets descriptive of characteristic appearances on the foliage. Their effect is to cause a progressive deterioration in yield, amounting, in the second year of infection, to 50 per cent. and more. Scotland, it appears, particularly north of the Grampians, enjoys a considerable immunity. The reason assigned is of much scientific interest. The guilty virus is ordinarily carried from one plant to another by insects—aphides are probably the worst offenders, and in the cool climate of the north of Great Britain 'green fly' is rarely found. Seed potatoes brought from Scotland may, consequently, be free from the disease. We have said 'may,' for Dr. Salaman has proved that the infection may be 'carried,' just as that of diphtheria and other human diseases may be. It is still unsettled in what degree the superiority of the Scotch seed potato is due to this tolerance, or to absolute freedom from the disease. Dr. Salaman does not go so far as some and state that the degeneration which attacks the tuber in the south is solely due to virus diseases: in his view it is still possible that there may be an environmental or physiological cause (such as immaturity) for the superiority of northern seed. There are many other unsolved problems, most of which our author notices; a bibliography of 177 items is evidence that he has cast his net widely.

When Dr. Salaman originally attacked the potato scientifically (under the inspiration, we believe, of the late Dr. Bateson) it was in the hope that the newly born science of genetics would give him useful results. It is somewhat sad to find the following passage under the heading of "The Application of Genetics to Variety Raising": "were we, however, to possess all the data we could desire we might still be wanting in the possession of that one essential gift, the eye of the fancier, the *flair* of the breeder. . . . Some of the best varieties have resulted from seed secured by impregnating some favourite but nameless variety with pollen recovered from several plants mixed together on the thumb nail before being applied to the expectant stigma." That is not the only discouraging feature to the geneticist. The potato, in common with so many varieties of cultivated fruits and vegetables in Britain, is genetically 'heterozygous,' and when 'pure lined' is likely to suffer a great loss of vigour. So much is this proving to be the case that it is doubtful whether—except in relation to plants which are normally homogamic, such as the cereals—the pure line will prove of much economic value.

Dr. Salaman is a thorough-paced Mendelian. To the presence of multiple genes he would attribute all the varying economic characteristics of the plant—yield, shape, cooking quality, and so forth. Of all the farm crops, none is more sensitive to environmental conditions such as soil, climate, and cultural treatment. Added to these there is the admitted variability due to the degree of infection by virus disease. On the figures adduced by the author, subject as they must be to these errors, it is permissible to question the existence of genuine segregation: the facts, such as they are, might be equally well explained on the unfashionable hypotheses of blended characters, or inheritance of acquired characters.

The book is produced in the style which distinguishes all the publications of the Cambridge Press, and it certainly constitutes the best textbook extant on the scientific problems of potato-breeding. As such, it should prove a welcome addition to the library of the scientific worker and, especially in regard to varieties, to that of the enlightened agriculturist.

Science, Invention, and Industry.

Old Trades and New Knowledge: Six Lectures delivered before a 'Juvenile Auditory' at the Royal Institution, Christmas 1925. By Sir William Bragg. Pp. xii + 266 + 42 plates. (London: G. Bell and Sons, Ltd., 1926.) 8*s.* net.

THE publication of Sir William Bragg's lectures to a 'juvenile auditory' at Christmas 1925 will enable a much larger audience than could be accommodated in the historic Albemarle Street theatre to enjoy what he has to say on the application of modern scientific discovery to the study of practical problems. Our earliest inventors are known only by their works, but just as it is one of the aims of the archæologist to inform us of the social habits of past races, so the scientific investigator finds it worth while to attempt to explain the technique used in age-long industries. By so doing he not only shows us the why and wherefore of processes evolved by centuries of patient groping and accidental discoveries, but also at the same time lays bare the fundamental principles on which future improvements depend. Through the ages men have gradually learnt to smelt, cast, forge, harden, temper, spin, weave, dye, fashion, fire, and glaze, producing utensils, implements, tools, weapons, garments, and ornaments, but never before has it been possible to unfold the laws on which such operations depend for their success.

The lectures cover wide and interesting fields of human endeavour, ranging from the study of the work of those who go down to the sea in ships to that done in peaceful cottages where wool and flax were spun into yarn by hand, and again to the hazardous business of mining, in which water, gas, and dust worked such havoc. In nothing has science wrought a greater revolution than in sea transport. To a seaman of the days of Elizabeth, the speed, regularity, and certainty with which passengers and goods are carried overseas to-day might well appear magical. Even in 1741, as we are told, Anson, after rounding Cape Horn, was ten degrees out in his reckoning. But with the coming of the sextant, the chronometer, and the Nautical Almanac, the mariner could fix his position with ease. Never was a nation's money more profitably spent than when Flamsteed was made Astronomer Royal at £100 a year, or Harrison given the £20,000 for his years of labour on the chronometer. To the compass and the sextant have now been added the gyro-compass, wireless time signals, wireless direction finding, leader cables, echo sounding, and even microphones placed on the bottom of the sea far from land. With such appliances collisions are avoided, channels navigated, and harbours entered even in fog.

While improvements in navigation have been mainly due to science, the progress in textile manufacturing owes most to the work of mechanical inventors. Kay's flying shuttle, Hargreaves' spinning jenny, Arkwright's water frame, Crompton's mule, and Cartwright's power loom were all designed to replace hand labour by mechanical appliances, and no one could wish for a clearer description of the processes involved than that given in the lecture on the weaver. To these inventors might have been added Eli Whitney, whose cotton gin made many fortunes, but riveted the fetters of slavery and led to civil war. In the textile industry, however, are many problems for research, and to these Sir William Bragg referred. In mining, too, it was the practical inventions of Savery, Newcomen, and Watt which made deeper mines possible, but it has been the study of scientific principles which has rendered coal-mining a hundred times safer.

It is in the lectures on metals, clays, and dyes that the reader will see how the whole armoury of modern science is brought to bear on apparently simple yet really difficult problems. Chemical analysis, X-ray examination, the microscope, the theory of electrons, atoms, and molecules and internal structure are all used in the attack, and each lecture provides evidence of the value of research to industry. To the ordinary observer nothing could look less crystalline than the clay on the potter's wheel, yet even in the finest clays composed of the finest particles there is a crystalline structure, but "unfortunately, the information, while quite conclusive on this point, is not easy to interpret because our knowledge of the new X-ray methods is only in its first stages, and some problems are too hard for us as yet." As it is with the work of the potter so it is with that of the dyer and the smith, and familiar operations carried out daily in villages all over the world are subjects for the highest studies. It is to be regretted that no such lectures as these are delivered to our working men, for after reading them it is easy to agree with the remark of J. A. Froude, who, addressing the students of St. Andrews, said "that every honest occupation to which a man sets his hand would raise him into a philosopher if he mastered all the knowledge that belonged to his craft." E. C. S.

A New Approach to Religion.

Reality: a New Correlation of Science and Religion. By the Rev. Canon Burnett Hillman Streeter. Pp. xiii + 350. (London: Macmillan and Co., Ltd., 1926.) 8s. 6d. net.

THE old apologetic for religion used to treat it, and its evidences, as if it were a branch of natural or historical science. Its truth depended on the accuracy of its cosmogony, the historicity of its mythology, and so on. All this is now recognised to be beside the point. Science and religion are regarded as two complementary methods by which different aspects of reality can be apprehended. Any satisfactory correlation of science and religion must supply a theory of the mutual relations of these two methods of approaching reality. So far as men of science are concerned, they may be said of recent years to have examined their own methods and subject matter pretty thoroughly. On the side of religion, too, a good deal has been done by philosophers such as Prof. Höffding, Prof. Alexander, and others. But we still await the promulgation of a satisfactory philosophy of religion by a theologian. The book before us makes a genuine and sincere attempt to supply this want.

Canon Streeter approaches the problem by first drawing a contrast between science and art. Between these two there are differences not only of method but also of subject matter. To take the latter point first; whereas science is concerned with the quantitative, or metrical, aspects of existence, art is concerned with its qualitative, or non-metrical, aspects. As regards method, there are two important differences: (1) Science states definitely, while art suggests; and (2) science explains observed data by bringing individual cases under a general law, whereas art reveals an inner spirit by embodying it in a concrete instance.

These contrasts between the methods and material of science and art serve to illuminate the contrasts between science and religion. Religion, like art and unlike science, is concerned with the non-metrical or qualitative aspects of the world, though it is with ethical rather than with æsthetic values that it deals. With regard to method, religion, like art, suggests rather than states; and, again like art, religion isolates some individual event or circumstance, and makes it symbolic of the whole of reality, or of some dominant aspect of reality.

Canon Streeter holds strongly that not only science, but also art and religion, reveal to us genuine aspects of reality, though they are different aspects. The contrast between science and religion may be expressed by saying that "what science gives us is a *Representation* of Ultimate Reality, and that this Representation is one that may be likened not so much to a picture as to a diagram." Whereas "what religion gives is also a Representation of Ultimate Reality, but one that is of the nature *not of a diagram but of a picture*." So that science and religion each give a representation which without the other is incomplete. One is like the ground-plan of Venice in Baedeker's guide, the other like Turner's famous picture, "Sunrise in Venice." These are complementary, though more or less incommensurable.

Science, then, supplies us with abstract diagrams, whereas religion, using the methods of art (myth, drama, parable, hymn, etc.), presents us with the qualitative aspects of reality by making us *feel* these "beyond the limits of our own experience." Hence, to test the 'truth' of any particular religion, its myths, etc., must be cross-examined. These, rather than the intellectual constructions of its theologians, indicate the spirit of a religion. No doubt, the question of the 'objectivity' of the 'values' of a religion is, in the end, a philosophical question. Religion cannot dispense with philosophy, or even with science, which contributes data for philosophical constructions, but philosophy is always secondary.

Canon Streeter himself is far from avoiding the philosophical issue. He applies the tests indicated above to Christianity. He inquires the meaning of the Christian 'myth' (which, however, he regards as history), and then proceeds to ask whether the values enshrined or symbolised in the myth are actually inherent in reality. He discovers that they are. He reaches this conclusion, not by the *a priori* reasonings by which theologians are accustomed to reach favourable results, but through a survey of scientific facts, largely from the biological sciences. Consequently, students of science will be able to follow this portion of the argument with patience, a thing they may often find difficult in this class of book. But in classing this volume with apologetic literature in general, we should not be acting fairly to Canon Streeter. It is a work of a very different type; one which all earnest students of the natural sciences would do well to read. J. C. H.

Our Bookshelf.

(1) *Man and Weather*. By Prof. Alexander McAdie. Pp. vi+99+18 plates. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1926.) 8*s*. 6*d*. net.

(2) *Air Ministry: Meteorological Office, London. A Short Course in Elementary Meteorology*. By W. H. Pick. (Published by the Authority of the Meteorological Committee.) (M.O. 247.) Second edition, revised. Pp. 127+8 plates. (London: H.M. Stationery Office, 1926.) 1*s*. 6*d*. net.

(1) Prof. McAdie's little book is written in an entertaining style calculated to impress meteorological principles on the memory. It consists of six popular lectures originally delivered in the Lowell Institute, U.S.A., in December 1924: (1) The strategy of weather in war; (2) weather in peace; (3) the structure of the atmosphere; (4) clouds, fogs and water vapour; (5) lightning; and (6) droughts, floods, and forecasts. The book should be most successful in awakening an interest in the subject, but it is marred by a quite unintelligible table on p. 62 representing the balance of precipitation and evaporation by land and sea. The unfortunate reader led into this quagmire is offered no helping hand from the author, who ironically observes: "From the data given above it would seem that the total rainfall for the globe is much less than the evaporation." This is no paradox; it is surely a physical impossibility that precipitation, being the complementary process of evaporation, should in the long run be less over the whole globe.

(2) Mr. Pick's book, which contains an appreciative preface by Dr. Simpson, is couched in the more staid language of a British Government publication. It skilfully compresses the fundamental principles of meteorology into a small compass, but in a future edition the author would do well to revise various statements in the light of most recent knowledge. Why, on p. 26, should relative humidity be deemed a more important meteorological matter than absolute humidity? Both are fundamental matters in the physics of the atmosphere, and as regards physiological effects it is now realised that absolute humidity is the more important condition. If there is a defective chapter in a generally good book, it is that on "Weather Lore," inasmuch as too strict a regard is paid to the letter of weather rhymes and too little to the spirit thereof. The countryman's 'February fill-dyke' is a very real phenomenon in seasonal hydrology, and one is not justified in assuming, as Mr. Pick does, that this necessarily implies a belief in much rain in a month which rainfall statistics show on the average to have relatively little rain. There is no reference whatever to the fact that towards the end of winter, after the season of small evaporation and little absorption of water by vegetation, the water-table is highest, and the rivers and brooks are normally fullest, being ready to cause flooding with less rain than would suffice at the beginning of winter in November. Again, it may be doubtful whether any one really takes the forty-day prediction associated with St. Swithin's literally; yet the spirit of the saying has just this much climatic foundation: that if disturbed weather once sets in about the middle of July, or for that matter at any time in July, it is liable in England to be very persistent, with a long succession of battering rainstorms running into weeks. We all know that type of July and August, and the countryman has embodied such climatic experience in a proverb the literal terms of which are (as Mr. Pick observes) quite untrustworthy. The actual date has probably no significance whatever, being just a landmark, and before the rectification of the calendar it corresponded to July 26.

L. C. W. B.

Penrose's Annual: the Process Year Book and Review of the Graphic Arts. Edited by Wm. Gamble. Vol. 29, 1927. Pp. xvi+127+70+72 plates. (London: Percy Lund, Humphries and Co., Ltd., 1927.) 8*s*. net.

This volume fully maintains the reputation the previous members of the series have earned for the editor and publishers. The newest item in it is a description by Mr. Fishenden of the Pantone process, which Mr. Ronald Trist has now so far perfected that he no longer objects to publication of its details. "Planished plates of suitable metal are first coated with an electro deposit of copper to a thickness of, say, five one-thousandths of an inch, and then with a chromium deposit of two ten-thousandths of an inch." The plate is coated with a solution of fish-glue and bichromate, exposed, washed, and burned-in as usual in photo-engraving. It is then treated with hydrochloric acid, which dissolves the chromium where it is exposed, but as it does not attack the underlying copper it cannot etch too deeply. The plate is next dipped into a solution of a silver salt, and then a few drops of mercury are rubbed over it. Amalgamation takes place immediately except in those parts where the chromium surface remains, and the mercury surface repels the ink without the use of water. The plate is now ready for trimming and mounting. The advantages of the process are many. It saves much time, as underlaying, re-proving, and fine etching are unnecessary. Fresh plates can be prepared as rapidly and cheaply as electros. Chromium "is five times harder than steel," and a plate that has been printed from every day for months shows by microscopical examination that each chromium-topped dot retains its original perfection. An impression from a Pantone block made with a 175 to the inch screen printed simultaneously with type on a rough surfaced paper shows how perfect the dot formation is.

The editor gives his usual summary of the year's progress, in which he points out the great advances being made in rotogravure colour printing now that the process is thoroughly practical, and at the end of the volume adds his "Note Book," dealing chiefly and critically with apparatus. "The Work of the Private Presses, VI., Essex House Press, 1898–1909," is treated of by Mr. Chas. T. Jacobi, with examples. A new system of music printing, "The Isotonic Notation," which is claimed to be simpler to learn as well as simpler to print than the usual notation, is described by Dom John Stéphan. There are other articles of technical interest and importance, besides the usual batch of illustrations to demonstrate the present degree of perfection to which the modern reproductive processes have attained.

English Life in the Middle Ages. By L. F. Salzman. Pp. 287. (London: Oxford University Press, 1926.) 7*s.* 6*d.* net.

THIS is an attractive, sensible, and useful book. Mr. Salzman has already published a similar work on the industries of England in the Middle Ages, and in this second volume he takes up the wider subject and does it even better. It is full of interesting and significant facts, well selected and well presented, with such an abundance of excellent illustrations as we may expect from the Oxford University Press.

Mr. Salzman's book is an admirable and more popular companion to "The Legacy of the Middle Ages" which the Oxford Press also published a few months since. The keynote of the two volumes is similar and a welcome sign of the new spirit in history teaching. The new point is the constant realisation of the fact that history is important to us just in proportion as we understand that we are ourselves a part of it and that the past has made us what we are. Mr. Salzman has this truth in view throughout, and when he talks either of literature, education, warfare, or law and order, is at pains to show, both how the work of our forefathers seven hundred years ago laid the foundations of our present life, and in what respects it has altered in the interval.

The chapters on education and literature are particularly good in this respect. In the former, Mr. Salzman makes clear the reason for the puzzling difficulty in the early study of mathematics. Why was arithmetic, which we now regard as the foundation of all exact intellectual discipline, then relegated to the Quadrivium or second stage in education, and only attempted by the few? The answer is that the Arabic system of numeration had not yet made its way into the schools, itself a historic fact of high social and intellectual import. In treating of language and literature Mr. Salzman brings out, with equal prominence and usefulness, the value of the contact of Anglo-Saxon and Norman French in the three centuries after the Conquest. To this we owe the simplification of English grammar, the wearing away of genders and inflexions, which has made our speech the universal and adaptable thing which it now is.

The illustrations have been ransacked from the libraries of western Europe, and are a striking proof of the wealth to be gained from the study of medieval illustrated manuscripts. F. S. M.

Transactions of the Institution of Chemical Engineers. Vol. 3, 1925. Pp. 137. (London: Institution of Chemical Engineers, 1926.)

THOSE holding the opinion that chemical engineering is as distinct and important a study as are the other better-known branches of engineering might well point to the contents of this volume in justification of their views. There is a series of papers on industrial water supply and steam pollution, an authoritative discussion of filtration, a description of the machines used in magnetic separation, and a couple of lectures on petroleum distillation and steam jets. The latest developments in steam generation are also considered, for the volume includes a good account of the Brunler internal-combustion boiler, which employs a flame burning continuously under water, and an interesting description of the Benson generator, in which water is converted into steam without ebullition by heating it under the critical conditions of temperature and pressure. These brief references will suffice to indicate the wide range of technological interest covered during the year. Of the papers themselves, it need only be stated that their general merit testifies to the vitality of this youthful Institution.

The Chemical Age Year Book, Diary and Directory, 1927. Pp. 155 + Diary. (London: Benn Bros., Ltd., 1927.) 10*s.* 6*d.* net.

IN addition to a very convenient diary, this book contains information of special interest to the chemist. Short notices are given of such subjects as research organisations, chemical and allied societies, patenting of invention, use of industrial chemicals, trade name of dye-stuff intermediates, certain stock-exchange prices, etc. Various tables of constants and chemical data are included. A chemical directory and a number of trade advertisements form a large part of the volume. At the present time there are so many excellent collections of physical and chemical constants available that the advisability of including such information, especially in an abridged form as in this diary, may be doubted. On the whole, however, the material selected for inclusion takes up only a small portion of the book, and the data may have definite value in special circumstances. The binding and general appearance of the book are excellent. This may partly justify the price, which is rather high compared with that of diaries generally. J. REILLY.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

Stresses involved in Tests of Hardness, and a Table of the Comparative Hardness of Certain Metallic Elements.

In Nature of Jan. 23, 1926 (vol. 117, p. 117), I gave a description of a method of determining 'Hardness,' in which a cone of the material to be tested was pressed against a hard surface (sapphire), and the area of the flat thus formed at the point of the cone by the application of a known force was measured, the hardness being defined as applied force ÷ area of flat, that is, as the greatest stress which the material can sustain.

In all forms of tests in which hardness is determined by the effects of a crushing force (whether by the indentation caused by a hard ball or the flattening of a point or ridge) the stresses involved can be expressed as a volume-compressive combined with two shearing stresses,* and the principal points of interest can be illustrated by a simple example. Consider a cube the edges of which are the axes x, y, z (Fig. 1), and let a compressive force F parallel to z act on the x, y faces, while the other x, z and y, z faces are free from any external force. These are the conditions for crushing and they can be satisfied by supposing that a volume compression $F/3$ acts on all the faces, while the shears the components of which, each equal to $F/3$ parallel to z and x and z and y, act to increase the pressure on the x, y faces and to neutralise that on the faces x, z and y, z.

If k and n are the coefficients of volume compressibility and rigidity respectively, the result of the application of F is that the distance between the x, y faces is diminished by $\frac{F}{3}\left(\frac{1}{3k}+\frac{2}{n}\right)$, while between the x, z and y, z faces the distance is increased by $\frac{F}{3}\left(\frac{1}{n}-\frac{1}{3k}\right)$, and the maximum value which can be given to F in this expression may be taken as defining the hardness of the material.

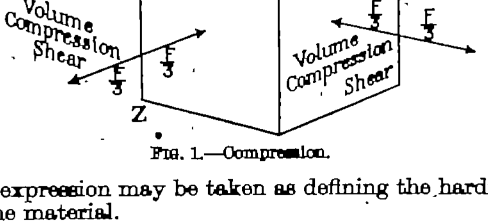

Fig. 1.—Compression.

In all solids there are two distinct limits to the strains which they can withstand, namely, increase of volume and shearing strain. There is no known limit to the volume compression which can be borne by a solid; in fact, k increases continuously with the pressure, and hence when fracture is produced by crushing, the cause is to be found in its inability to resist shear.

Whether the coexistence of volume compression with shearing stress alters the limits of strain for the latter is not known: it seems probable, however, that it does, or at any rate may, do so: but assuming for the moment that k and n are independent, the hardness of a solid is three times the force required to cause it to shear.

In addition to the stresses just mentioned, reference must be made to the friction between the surface of the test piece and the harder substance by which the crushing force is applied. This effect, which depends on the coefficient of friction, differs for each material, but in general adds to the apparent 'hardness' by opposing sliding motion which occurs at the area of contact.

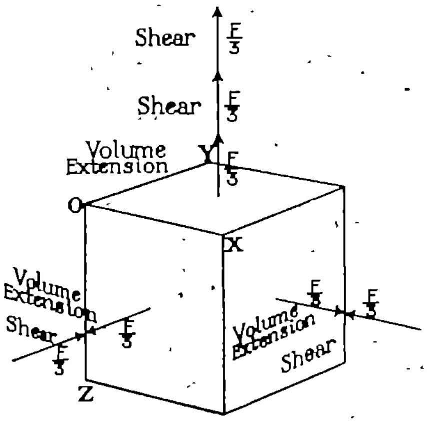

Fig. 2.—Extension.

In tensile tests the character of the stresses is inverted: volume compression is replaced by volume extension and the direction of the shear forces is reversed (Fig. 2).

In such tests rupture may occur either because the substance cannot bear the requisite volume extension or the requisite shear, and the nature of the break depends on which of the limits is the greater. When the limit of volume extension is small the material may be malleable although not ductile, but if it is ductile it is necessarily also malleable.

The accompanying table gives a list of 24 metallic elements arranged in order of their hardness. For

Table of 24 Metallic Elements arranged in Order of Hardness.

Hardness stated in tons/square inch.

	Metal.	Hardness.	Remarks.
1	Iridium	240	*M.*
2	Molybdenum	168	*M.* Wire.
3	Tungsten	144	Thin plate, slaty fracture.
4	Rhodium	128	*M.* Wire.
5	Nickel	112	*M.* Wire.
6	Chromium	109	Cast: Crystalline aggregate.
7	Cobalt	99	*M.* Cast.
8	Titanium	77	Plate, slaty fracture. Brittle.
9	Manganese	60	Cast: Crystalline aggregate.
10	Iron	56	*M.* From ingot made by Marriot process. Pure.
11	Copper	50	*M.* Wire.
12	Aluminium	29	*M.* Wire.
13	Vanadium	28	Crystalline aggregate. Brittle.
14	Palladium	28	*M.* Wire.
15	Silver	25	*M.* Cast.
16	Magnesium	22	*M.* Cast.
17	Zinc	21	*M.* Cast.
18	Gold	20	*M.* Cast.
19	Calcium	17·5	Crystalline aggregate. Brittle.
20	Cadmium	12	*M.* Cast.
21	Bismuth	8	Large, crystal.
22	Tin	7	*M.* Cast.
23	Lead	3	*M.* Cast.
24	Thallium	1·4	*M.* Cast.

most of these the hardness is of little practical importance, but the table does show how capricious this quality is and how apparently unrelated either to density, atomic weight, or position in the periodic classification.

Much depends on the condition of each specimen and on the treatment to which it has been subjected, as, for example, whether it is cast, forged, rolled, or drawn. In the cast state some of the metals consist of an aggregate of small crystals which separate comparatively easily, and in these cases the value found for their hardness relates to the junctions of the crystals and not to the crystals themselves.

Only those metals which are, to some extent at least, malleable, give a true measure of hardness in this form of test. (These are marked *M* in the table.) The others show the apparent hardness of the particular specimen used, depending, in part, on the closeness of the aggregation of small crystals, or on the relation of the crystallographic axes to the direction of the crushing force.

Many alloys have been tested. Various kinds of steel range from 700 tons/square inch for hardened carbon steel down to 56 tons/square inch for pure iron, and it is worth while to notice that none of the reputedly hard metals such as iridium approach the former figure.

A. Mallock.

9 Baring Crescent, Exeter.

Is Darwinism Dead?

The review in Nature of Jan. 15 of my criticism on Mr. Wells's somewhat antiquated biology has only just been shown to me, hence the delay in my sending this letter. I will make it as brief as possible, for I am only concerned with showing that the distinguished reviewer, Sir Arthur Keith, though he has doubtless been given a few sentences from my book for purposes of quotation, has not read the book itself.

(1) He says: "So adroitly does Mr. Belloc cover his verbal tracks with a smoke screen" that he cannot determine whether I am a 'fundamentalist' or a 'Darwinian.' As a fact, I cannot conceive myself being either, but the point is that no one who had read my book could have imagined that 'Fundamentalism' was the issue. The only issue was whether natural selection were the process whereby the differentiation of species came about.

(2) He says that I give 'with approbation' St. Thomas's conclusion that the creation of man was (in scholastic language) 'immediate': that is, special and direct. Had the reviewer read my book he could never have sincerely written that. I quoted this *exceptional* conclusion on immediate human creation to show that St. Thomas probably thought the creation of animate beings other than man to be 'mediate': that is, evolutionary.

(3) The reviewer is "forced to the conclusion" that I have never read "The Origin of Species." If he had read my book he could not possibly have been 'forced' to so foolish a conclusion. All I say in it on this matter is written in direct relevance to that work—with its only original (and erroneous) thesis of natural selection as the machinery of differentiation.

(4) He says that "Mr. Belloc resuscitates this ancient misrepresentation of 'accidental' and 'single' variations," and follows the sentence up with a good deal of irrelevant abuse. Had he read my book he would have found that I know all about Darwin's retreat in this matter, *and* am careful to point out that it was a muddled retreat. For the mathematical argument against natural selection applies just as much to a thousand cases out of a million as to one out of a thousand.

(5) He so completely misunderstands the example I take from the growth of horns that he clearly has not read the original passage but is judging from a chance sentence put before him, and even that he fails to grasp. My point—clearly stated, emphasised, reiterated—was that multiple adaptation is mathematically incompatible with the blind mechanical action of natural selection. Multiple adaptation presupposes design. The citation of the hormone as a disproof of God is wildly off my point. One might as well say that the presence of glue in a piece of woodwork disproved the presence of a carpenter.

(6) I have kept to the last the most damning count in this indictment. The reviewer sets me down as owing my remarks entirely to Mivart, as having merely copied Mivart's work of more than half a century ago: implying my ignorance of all since. Had he read my book he would have seen that I quoted from authority after authority among the highest names in modern biology from the beginning of the discussion to works which appeared so recently as three years ago. I give their actual words, which prove with what increasing force the old-fashioned Darwinian theory of natural selection has been beaten down. I end by a list of no less than forty such names—I might easily have made it a hundred. No one who had read my book could possibly have missed this continued and repeated citation of authority from every side, which is the principal feature of this section.

I conclude, therefore, that the reviewer has not read my book; for I hope that not even the most violent religious animosity could lead him to deliberate misrepresentation.

H. Belloc.

Not only did I read Mr. Belloc's book with great care, but I also took the trouble of turning up the works of some of the authorities he cites. On p. 12 he mentions, with bated breath as it were, "the great work of Vialleton." This "great work" is a very good elementary treatise on embryology which Prof. L. Vialleton, of the University of Montpellier, wrote for his students, and it stands in much the same relationship to the works of Charles Darwin as do those of Mr. Belloc to Shakespeare's.

Mr. Belloc cites Vialleton as his authority for denying the possibility of birds having been evolved from reptiles. On searching Prof. Vialleton's "Éléments de morphologie des vertébrés"—published in 1911—I found on p. 611 that after citing what Huxley, Owen, Seely, Mivart, and Gadow had to say about the matter, Prof. Vialleton concludes thus: "L'origine des oiseaux reste donc dans le plus complet mystère," which is a very different thing from denying their origin from reptiles. I have collected many other errors of a like kind, enough to convince me that Mr. Belloc's references are untrustworthy. Many of the authorities he cites, such as my friend the late Prof. Dwight, of Harvard, belonged to the generation which never succeeded in assimilating the teachings of Darwin.

Arthur Keith.

Radioactivity and the Heat of the Earth.

In his presidential address to the Geological Society, abridged in Nature of Jan. 1, Dr. J. W. Evans refers (page 15) to the above topic in the following words: "although the whole of the energy given out by radioactive elements, when isolated, is converted into heat, it is probable that a considerable proportion of the energy liberated by such elements, when they occur as rock-constituents, is used up in effecting physical, chemical, or atomic changes in the surrounding minerals.

"That much of the radioactive energy set free in the disintegration of radium and thorium is absorbed in other ways than in raising the temperature of the rocks is clearly shown by the formation in certain circumstances of 'pleochroic haloes' round radioactive minerals. This occurs especially in the case of zircon embedded in biotite mica. Such a halo is a sphere with a radius of about 30 microns, and has a minute zircon at the centre. It is of a darker and a deeper brown and far more pleochroic than the rest of the mica. The difference is usually assumed to be the result of ionisation by the radiations from uranium and thorium contained in the zircon. The possibility of atomic changes under the influence of the α-rays must, however, not be ignored.

"The formation of the haloes must involve a considerable absorption of energy, the magnitude of which will be realised when it is remembered that the mass of the halo may be some 15,000 times that of the zircon at its centre, and more than 300,000 times that of the uranium and thorium to which the halo owes its existence. Nor is it probable that this absorption is confined to the pleochroic haloes.

"It is, therefore, doubtful whether there is any considerable excess of radioactive energy available for raising the temperature of the earth."

In the absence of any experimental evidence in their support, such views as those expressed by Dr. Evans cannot be allowed to go unchallenged. They are liable to mislead, and to put unnecessary difficulties in the way of those who are interested in the trend of this aspect of geophysics, but are not sufficiently versed in the facts of radioactivity to form an independent judgment.

The occurrence of pleochroic haloes around radioactive inclusions in certain minerals certainly does show that *some* of the energy of the radiations emitted by the inclusions produces effects other than thermal ones; but before we are justified in stating that *much* of the energy is so expended, we must make an appeal to the available evidence, and this decides conclusively against Dr. Evans's view.

There is no evidence in favour of the view that an *appreciable* proportion of the energy liberated by the radio-elements, when they occur as rock constituents, is used up in producing changes of the kind suggested by Dr. Evans. In all determinations of the heat developed by radium, alone and with its disintegration products, the substance has been enclosed in a glass tube of sufficient thickness to absorb the α-rays completely, as well as more than thirty per cent. of the β-rays, and it is well known that the glass container rapidly becomes coloured by the action of the rays, the effects being quite analogous to those observed in minerals. Were Dr. Evans's views correct, we should expect that the heat development as determined experimentally would be considerably less than the value calculated from a knowledge of the number and energy of the rays involved; but this is far from being the case. Thus, for radium alone, that is, without disintegration products, the calculated heat development per gram of the element is 25·47 cal. per hour, whereas the measured value is 25·1 cal. per hour (Rutherford and Robinson) or 25·2 cal. per hour (Hess), and these experimental values probably require to be raised by 0·2 or 0·3 cal. per hour owing to incomplete absorption of the γ-rays from radium in the apparatus used (see NATURE, 116, p. 897, 1925).

Almost equal agreement is obtained between experiment and theory when we consider the total heat developed by 1 gram of radium together with its short-lived products. The results of experiment yield 135 cal. per hour (Rutherford and Robinson), and 137 cal. per hour (St. Meyer and Hess), both results probably being somewhat low owing to insufficient allowance for the effect of the γ-rays. On the assumption that all the energy of the rays is converted into heat, and with the latest data, the total heat production of radium and its short-lived products in equilibrium works out to be 137·7 cal. per hour per gram of the parent element (see *Phil. Mag.*, vol. 2, p. 1227, 1926). From the close analogy between the effects in glass and in minerals, it seems safe to conclude from these results that the energy of the radioactive rays expended in the manner suggested by Dr. Evans does not amount to one per cent. of the total energy, and is probably not more than about one-tenth of this value.

Determinations of the heat production in uranium and in thorium minerals have also been carried out experimentally. Here the effects are so small that the results cannot be expected to agree very closely with the calculated values. Nevertheless, the agreement is surprisingly good and gives additional support to the conclusion reached above.

Another aspect of the problem is worthy of mention. A rough calculation indicates that the energy of the α-particles emitted by the inclusion during the life of a representative pleochroic halo may amount to several hundred micro-calories. Were an appreciable fraction of this energy to be stored in the halo and liberated say by the application of heat, it is to be expected that the halo would attain a temperature reckoned in thousands of degrees. But nothing so violent occurs in practice. Glasses and minerals coloured by radioactive rays are restored practically to their original condition when their temperature is raised to from 200° to 400° C., and in the process they exhibit the phenomenon of thermo-luminescence with the emission of light of characteristic colour; but the energy so liberated does not produce catastrophic results, and is manifestly small.

The problem of the thermal history of the earth is unquestionably one of great difficulty, and in its elucidation much still remains to be done. But we cannot lightly dispose of the fact that radioactive processes must have exerted a profound and indeed a controlling influence in maintaining that youthful vigour which has characterised our planet throughout geological time. The effects of uranium, thorium, and potassium cannot be ignored in geothermal considerations, and in the absence of any experimental evidence to the contrary, we can continue to assert with confidence that practically the whole of the energy associated with the radiations emitted by these elements is available for raising the temperature of the rocks in which they occur.

ROBERT W. LAWSON.

University of Sheffield.

Progressive Lightning.

IN NATURE of Nov. 20 last, Prof. C. V. Boys has an article on some attempts to photograph 'progressive lightning,' in which he refers to observations of 'multiple flashes'—that is, flashes succeeding each other along the same path.

There is no doubt of the reality of these *appearances* of multiple flashes, but I have very serious doubts of there being more than one flash in reality.

Córdoba is an excellent place for the observation of lightning, as the electrical displays are frequent during the summer months, and they are some of the strongest I have ever witnessed (in several parts of the world). The Observatory is well situated on the bluff overlooking the river, with a clear view over the pampas in almost all directions for many miles. Displays are often observed at distances of forty to fifty miles and many pass directly over us. Houses of the astronomers and other buildings have been struck several times during my residence here, and one of the steel and concrete domes was struck once. In the early history of the Observatory one of the astronomers was killed in his room in the assistants' house.

Altogether I have observed many hundreds of brilliant flashes, as many close ones perhaps as distant ones. I have many times observed these 'multiple' flashes, usually two or three succeeding each other. They are strikingly clear and sharp and sometimes appear to vibrate. They certainly give the impression of there being distinct flashes, but I cannot conclude that this is a fact, because they are invariably seen only when the flashes are distant, usually too distant for there to be any sound. Now we have every reason to expect that just as many of this type of flash should occur near by as at a great distance if there are really several flashes instead of one. But in all my experience I have never seen a case near by; they are always at a great distance. One of the strongly marked characteristics of the near flashes, in appearance as in sound, is their sharpness and shortness—the nearer the shorter. Flashes within a hundred yards are sensibly instantaneous to both eye and ear, and *always single*.

From these facts I conclude that the 'multiple' flashes are due in some way to erratic refraction in the atmosphere.

It would not be without value perhaps for two observers, some twenty or thirty miles apart and in telephonic connexion, to test this matter by observing whether the flashes which appear multiple are observed to be so at both stations in cases where the flash is very close to one station and distant from the other.

C. D. Perrine.

Observatorio Astronómico de la
Nación Argentina,
Córdoba, Dec. 19.

I have to thank Dr. Perrine for his observations on my article on "Progressive Lightning." They are interesting as indicating some difference in the appearance of lightning in the Argentine, where the strokes are exceptionally strong, and that of lightning in Great Britain. Here without any question the appearance of the multiple flash is found when the distance is as little as a kilometre, and I certainly believe much less. In Cordoba Dr. Perrine only observes this when the flashes are so distant that thunder is barely heard. Such a distance here is from sixteen to twenty kilometres. I suppose here, with a flash near enough, even if it were multiple, the eye would be so dazzled by the primitive flash as not to be able to see those that follow, but it is difficult to account in this way for the great distance implied by the faint audibility of the thunder. I have seen a large number of photographs taken with an ordinary camera held in the hand, and not intentionally moved as Dr. Hoffert's was, but nevertheless not really fixed, which show the multiple flash, and the size of the flashes on the plates indicates that they must have been fairly near. At any distance such as sixteen kilometres the flash would occupy but a small portion of the plate.

I could have wished that Dr. Perrine had supplemented his eye observations with photographic records which would be easily obtained in so favourable a locality. It would appear that it is a suitable place for my proposed rocket experiment, that is, if the descent of the empty case and stick is not a danger as it is with me. I might add to my previous observations that the rocket, preferably of about three centimetres calibre, should be without a head but with one calibre extra of solid composition over the hollow left by the spindle, and that the usual proportion of coarse charcoal be retained, so that the whole length of the trail should contain live sparks to improve its conductivity. Such a rocket would attain perhaps double the usual height and move with immense speed.

If any question should arise as to the conductivity of the trail, this could be assured by allowing the rocket to carry up a hundred metres or more of fine copper wire arranged like a life-line so as not to kink. Owing, however, to the inconvenience of laying this in thunder rain I would first rely on the trail.

C. V. Boys.

The Polishing of Surfaces.

In Nature of Sept. 4, 1926, Mr. J. M. Macaulay suggested that, in the process of polishing, surface layers were actually melted—the energy supplied being ample to produce melting, and the difficulty with regard to temperature disappearing if the heat, due to friction, was produced at points of contact rather than over large areas (the temperature at a *mathematical* point-source of heat being infinite). In Nature of Jan. 29, Mr. N. K. Adam contends that "it does not seem necessary to suppose that actual liquefaction occurs," since "the polisher will tear away the surface particles of the glass" and "some of these particles will naturally be redeposited elsewhere at random, thus forming the amorphous layer." Now it is difficult to believe that particles of glass spread at random will have a polished surface, even although these particles be of molecular dimensions, since each particle will be covered by a surface layer of gas, or other substance, which will prevent cohesion at ordinary temperatures. It might be contended that in the polishing process the particles torn from the surface had no time to assume a surface layer, but that is surely a highly improbable assumption. It seems to me that Mr. Macaulay's letter gives the key to the rational explanation of surface polish.

James Muir.

The Royal Technical College,
Glasgow, C.1, Jan. 31.

Perhaps my letter of Jan. 29 requires some further explanation. I did not suppose that the particles were redeposited as a dust on the surface, expecting them to coalesce spontaneously to a polished layer; this would of course be impossible. If, however, we examine what would happen to the *molecules* on the liquefaction hypothesis and on mine, it appears that mine is simpler and more probable. On the liquefaction hypothesis, the forces of adhesion between the moving polisher and the surface (constituting friction) are supposed to produce heat first; this heat then liquefies the surface layer. That means that the friction sets up irregular thermal vibrations in the surface molecules; it is then necessary to suppose that the energy of these vibrations is dissipated less rapidly than it accumulates, owing to the small thermal conductivity of the material; finally, the vibrations become so intense that the molecules can no longer stay in their positions in the solid, and 'melting' occurs. It must further be supposed that the surface layers remain liquid sufficiently long to flow to a plane surface, with whatever assistance may be given by the motion of the polisher.

My hypothesis states that the polisher adheres to the surface, dragging away small particles. In the same manner, at other localities, the adhesion of the surface to the polisher drags back some of the particles adhering to the polisher. Thus the polisher acts as a temporary support on which many particles are removed from one point to another. Hardy's work on static friction shows that this tearing away occurs under quite light pressure, despite the possible presence of surface layers of gas. Clearly the random removal of particles, only some of which need be of molecular dimensions, from one point of the surface to another, must result in forming an amorphous layer, if continued long enough.

If there is energy enough to move the surface molecules as a result of intense thermal vibrations —which is all that melting amounts to—there must be ample energy for the mechanical transportation of my hypothesis. Thermal vibrations are a notoriously inefficient method of producing a specific mechanical result. The result required is the moving of molecules from an ordered space lattice to a disorderly, amorphous layer; and the motion of the polisher, picking up and redepositing particles elsewhere, seems admirably adapted to produce this.

I have some difficulty in accepting Mr. Macaulay's theory that the polisher only touches the surface at a point. This seems almost incredible, with a moving piece of flexible material such as wash-leather. Further, even supposing that the contact approximates to point contact in the first stages of polishing, through projections on the surface alone touching the polisher, one would expect that these points would be worn or melted away long before the completely polished, plane surface was attained, so that there would be contact over considerable areas in the later stages of polishing. I should expect heat to be lost from the area polished at nearly the normal rate of loss from a plane area the size of the apparent contact between polisher and surface.

N. K. Adam.

The University,
Sheffield, Feb. 3.

Wheat in 3500 B.C.

A short time ago I received from Prof. Poulton and Sir John Russell small samples of wheat grains found by Prof. Langdon, of Oxford, in a vase on the site of an ancient Sumerian house at Jamdet Nasr, seventeen miles north of Kish in Mesopotamia.

The wheat, which Prof. Langdon dates 3500 B.C., is of much interest, not only on account of its antiquity, but also because its grains are of a type associated with the more highly developed races of this cereal.

The identification of the races of wheat by their grains only is always difficult, and sometimes impossible. In this case, however, I conclude, from the features noted below, that they belong to a variety of Rivet wheat (*Triticum turgidum*), a wheat, so far as I am aware, unknown to the ancient Egyptians, and the first authentic ancient sample of this race which I have seen.

The characters of these grains, namely, large average size, blunt apex, very prominent dorsal hump, and asymmetry or lop-sidedness of some of the grains due to pressure of the flowering glume on one side, are all characters of *T. turgidum*, and the grains are matched exactly by several modern varieties, which we grow annually at the Agricultural Botanic Garden at Reading (see Fig. 1).

According to a letter from Prof. Langdon in the *Times* of Feb. 3, the opinion has been expressed that the grains are those of Bread wheat (*Triticum vulgare*) or of Club wheat (*T. compactum*), but the grounds upon which these conclusions are based are not given.

The view that they belong to *T. vulgare* may, I think, be neglected, for their prominent dorsal hump and the asymmetrical form of some of the grains are opposed to this identification. I am also unable to agree with the suggestion that they are grains of *T. compactum*. All known varieties of this race of wheat have been grown here and studied during the last thirty years, and the majority possess grains similar in form to those of *T. vulgare*, but smaller; a few uncommon representatives have the dorsal hump of *T. turgidum*, but the large size of Prof. Langdon's grains is against their classification with these.

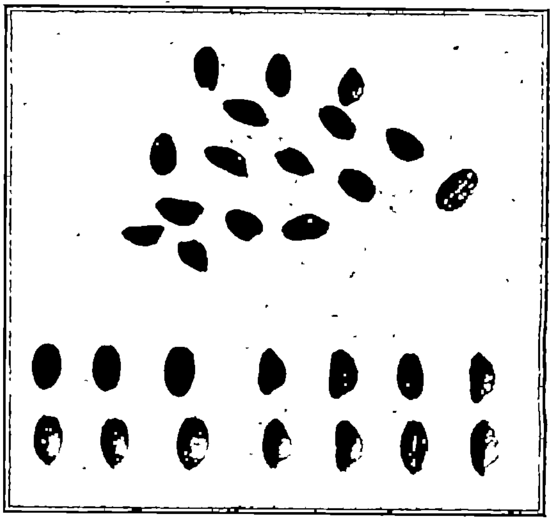

Fig. 1.—Upper group: grains of wheat found in a vase on the site of a Sumerian house (3500 B.C.). Two lower rows: grains of modern Rivet wheat (*Triticum turgidum*) for comparison. (Natural size.)

All trustworthy evidence we possess shows that Emmer (*T. dicoccum*) was the wheat first grown by the oldest civilised peoples, and I am of the opinion that these grains belong to the Emmer group of wheats; they leave us still without any clue to the origin of the Bread wheat series, but I hope that further discoveries in the region from which these have come will ultimately provide material for the solution of the problem.

Apart from its botanical interest, Prof. Langdon's discovery is of much importance, in that it has proved that the Sumerians were in possession of an advanced type of wheat at a very early date.

John Percival.

The University, Reading,
Feb. 5.

The Length of Light Quanta.

At the meeting of the American Physical Society in December last, Lawrence and Beams reported experiments showing that the length of light quanta is smaller than 3 cm. Experiments were made by me in the spring and summer of 1926 on the same subject with a similar result, though by a different method. While the experiments were begun, however, a theoretical consideration showed that a positive result would be very improbable, and so the results were not published. The reasoning was as follows:

It is well known that it is possible to obtain an oscillogram of a radio wave and that by a proper choice of apparatus (Dufour oscillograph) one can photograph the wave form for periods which are small fractions of a wave-length. No matter how small this fraction is, the photographic trace gives directly both the sine character of the wave and its frequency because it satisfies the differential equation $\frac{d^2y}{dt^2} + (2\pi\nu)^2 y = 0$. Therefore, every-day electrotechnical measurements show that quanta of long wave-length have an effective length (in the sense of Lawrence and Beams) which is very much shorter than the wave-length of the radiation.

In my experiments a glass prism spectrograph and a photographic plate were used instead of a photo-electric cell. A Kerr cell with nitrobenzol as material was operated by means of sustained oscillations of 30 metres wave-length. Spectra of various sources were photographed with the cell operated as described above, and these spectra were compared with those obtained by applying a small direct field to the cell. This field was adjusted by trial so as to give the same intensity as the high-frequency alternating field. In all cases the spectra were identical.

It was expected that if light quanta should have a length corresponding to the mean life of an atom, then since for an opening time of $T = \frac{1}{2} \times 10^{-7}$ some lines are longer and some shorter than T, a change in the relative intensity of lines would be observed. No such effect was observed. Further, if the nicols were crossed well, the direct field which had to be applied was the root mean square value of the alternating.

The spectrograph was a low-dispersion, large-aperture Zeiss instrument kindly loaned by Dr. Meggers of the Bureau of Standards. It was naturally impossible to observe the theoretical broadening by means of it.

Needless to say, the experiments of Lawrence and Beams and those of the writer are a continuation of the experiments of G. P. Thomson with canal rays.

G. Breit.

Department of Terrestrial Magnetism,
Carnegie Institution of Washington.

A Polymorphic Oligochæte.

During a recent visit to North Wales an effort was made to increase our knowledge of its oligochæte fauna. The most interesting result was the discovery in three different localities of as many different forms of one worm, usually known as the Venetian worm (*Eisenia veneta* Rosa). In a rubbish heap near some gardens in Colwyn Bay I came across one specimen which closely resembles Rosa's type. Hitherto this has only been found at Kew, where it is probably an introduction. The Welsh specimen, however, has tubercula pubertatis on four segments on one side, while the normal two are on the other. This recalls the variety *zebra*. In a garden near by several specimens of a very different form occurred. In almost every British earthworm the girdle is much more fully developed dorsally than ventrally, but in these the conditions were exactly reversed. So characteristic is the appearance as to justify a distinguishing name, and this variety may be known as *tumida*. The third form was found under the bark of a tree along with several dendrobænic worms, and this closely resembles some of the other varieties which have been described.

We now have at least half a dozen well-marked varieties of this most unstable of all British worms, the list being as follows:

1. *Eisenia veneta* Rosa, *typica*. Kew Gardens, Sept. 1909. Colwyn Bay, Sept. 1926.
2. Var. *zebra* Mich. Ireland. Southern, 1909.
3. Var. *hibernica* Friend. Dublin, June 1892.
4. Var. *dendroidea* Friend. Malvern, 1909.
5. Var. *robusta* Friend. Kew, Oxford, Malvern and elsewhere, 1909.
6. Var. *tepidaria* Friend. Oxford, 1904.
7. Var. *tumida* Friend. N. Wales, 1926.

Some interesting problems present themselves in connexion with these facts, and a wide field for observation and investigation is opened up thereby.

Hilderic Friend.

"Cathay," Solihull, Jan. 18.

Tuning-Forks with Parallel Prongs.

Attention has been directed by Mr. Maxwell (Nature, Jan. 22, p. 124) to an apparently extraneous overtone heard in tuning-forks, the pitch of which is one octave above the fundamental tone of the fork.

An explanation of the presence of this tone was supplied by the late Lord Rayleigh, who ascribed it to the action of unbalanced centrifugal force set up by the motion of the ends of the prongs in curved paths ("Collected Papers," vol. 1, p. 318).

A state of oscillatory tension thus comes into existence within each vibrating prong, and the frequency of this oscillation is double that of the transverse vibrations of the prongs themselves. The same holds for the bases of vibrating reeds and the ends of a vibrating wire.

Rayleigh obtained the octave tone by using a 256 fork on the box of a 512 fork. It may also be brought out by means of a Helmholtz or other resonator.

As Mr. Maxwell remarks, it is also heard when the butt end of the vibrating fork is placed on a table. With gentle pressure, the fundamental alone is heard, but with increased pressure, the octave above becomes audible, the pressure having to be increased as the amplitude of the prongs diminishes. By using a domestic spring-balance it may be found that the pressure required to bring out the octave of, say, a 512 fork with parallel prongs rises from 1 or 2 ounces to 6 or 7 ounces while the octave remains audible.

When the prongs are inclined to the stem, a component of the centrifugal force is not transmitted to the stem, and the vibration of the butt end due to this cause is of smaller amplitude.

G. E. Allan.

Department of Applied Physics,
University of Glasgow.

[Mr. W. Anderson, College of Technology, Manchester, writes to point out that the effect described by Mr. Maxwell is also referred to by Lord Rayleigh in his "Theory of Sound," vol. 2, p. 463.—Editor, Nature.]

Adsorption of Dyes to Silver Halides: a Correction.

In a letter on this subject (Nature, Dec. 25, p. 913), the number of dye molecules adsorbed at saturation to the surface ions of silver bromide crystal was given as about 1 dye molecule to 20 ions at pH 5·5. An error in the calculations has been found, which shows that the adsorption should be just ten times as great, namely, 1 dye molecule to about 2 ions of the lattice surface. Inasmuch as the dye adsorption increases with increased pH, it is probable that the limiting adsorption density occurs at the formation of a complete monomolecular layer. It may be possible to test whether the maximum sensitising effect is reached before this layer is completed.

S. E. Sheppard.

Eastman Kodak Company,
Rochester, N.Y., Jan. 12.

George Henry Lewes.

I should esteem it a great favour if any one possessing a photograph, however small, of George Henry Lewes about 1875, would allow me to have it copied.

E. Sharpey-Schafer.

University New Buildings,
Edinburgh, Feb. 7.

The Electron as a Vector Wave.

By Prof. C. G. DARWIN, F.R.S.

THE spinning electron of Uhlenbeck and Goudsmit has brilliantly filled up a serious gap in atomic physics, but, while we cannot withhold our admiration from its successes, it is only fair to consider certain defects from which it suffers. When what is required is to double the number of states of the electron, it is at the least generous to introduce three extra degrees of freedom and then make an arbitrary (though not unnatural) assumption which cuts down the triple infinity to two. The electron is in fact given a complete outfit of Eulerian angles, even if it may not be necessary so to express the matter explicitly. Now we regard the electron as the most primitive thing in Nature, and it would therefore be much more satisfactory if the duality could be obtained without such great elaboration. The present communication is an attempt to do this; it is, I think, promising, though falling short of complete success, but as future stages would involve a very large amount of work, it seemed better to expose the theory to criticism at once, in case some serious objection can be made against the whole principle of it.

The above criticism of the spinning electron is perhaps partly aesthetic, but there are others. Thus though dynamical principles have been shown by both Thomas (NATURE, 117, 514) and Frenkel (*Zeit. f. Phys.*, 37, 243) to give doublet spectra correctly, yet neither of them has succeeded in casting the result in a rigorous Hamiltonian form, so that all the work on the spinning electron has a 'dressed-up' appearance, lacking in formalism. Again the wave mechanics (in this the matrix mechanics is better) definitely excludes half quantum numbers for the spin, and so would lead to triplets instead of doublets—1, 0, −1 instead of $\frac{1}{2}$, $-\frac{1}{2}$. It is perhaps also not unfair to argue that the quantum mechanics is largely guided by the principle that nothing unobservable is to be explained, so that a theory is to be regarded as suspect, which introduces a large number of higher quantum states of rotation, only to bar them later.

The advent of the wave mechanics must have suggested to many a way out of these difficulties by assimilating the electron to a transverse rather than a longitudinal wave, for this at once provides the number of states with the necessary factor 2. The idea involves difficulty when more than one electron is present; we shall discuss and tentatively meet this difficulty later, but a necessary preliminary is to obtain a system of equations for the single electron. In doing so we are endowing it with an intrinsic duality to which there is no direct analogue in dynamics, so that the only guidance we have is that the equations must be of the wave form (to conform to classical dynamics in the limit), and must be such as to give correctly the structure of doublet spectra. It is scarcely conceivable that the equations should not involve the Schrödinger functions, and this excludes, as a great many trials showed, any wave type built on lines like the electromagnetic equations, for the Schrödinger function will not tolerate a *divergence* relation of any kind. Moreover, such types of wave do not appear to exhibit those qualities of approximate degeneracy which are implied by the Paschen Back effect. It is, however, possible to construct by a much more inductive process a system of waves, of a vector character though not transverse, which completely reproduces the doublet spectra, and then to generalise from this.

The general character of doublet spectra is given by having two *dependent* variables, each of which nearly satisfies the same equation, say $Df=0$ where D, depending on x, y, z, t, is the operator in Schrödinger's equation. Let α, β, γ, δ be small perturbing operators in x, y, z, t, and solve the equations

$$\left.\begin{aligned} Df+\alpha f+\beta g&=0 \\ Dg+\gamma f+\delta g&=0 \end{aligned}\right\}, \qquad (1)$$

Near any characteristic W_n of $Df=0$ there are then two solutions of (1) with just the right type of degeneracy. Our task is, therefore, to discover forms of α . . . δ which will give the observed values of W for doublet spectra, and this is not so hard as might appear at first sight.

The *terms* of a doublet spectrum are very conveniently epitomised as follows. We take $k=0$, 1, 2 . . . for s, p, d . . . and $-k \leq m \leq k$, m being integral. For all values of m solve the following equations for $\overline{W}$:

$$\left.\begin{aligned} a_m[\overline{W}-\rho m-\omega(m+1)]-b_{m+1}\rho(k+m+1)&=0 \\ b_m[\overline{W}+\rho m-\omega(m-1)]-a_{m-1}\rho(k-m+1)&=0 \end{aligned}\right\}, \quad (2)$$

where ρ, ω are the Landé constant for doublet separation and the normal Zeeman effect in energy units. It will be found that the solutions give $\overline{W}$ as the distances of all the Zeeman levels from the centre of gravity of the terms at all strengths of magnetic field. (The equations give two end solutions of different form from the others, and these give the two extra members for one component of the doublet.) The above equations were found by solving the complete problem of the spinning electron and then adjusting the constants by trial; a_m and b_m are then the coefficients of a spherical harmonic for the two directions of spin. We shall not further inquire into their meanings; when suitably normalised they will of course be connected with intensity, but we need feel little doubt that intensities will come right on practically any theory.

By trial with $k=1$ and 2 it is easy to construct the operators α . . . δ and these are then found to work for all cases. The equations (1) are:

$$\left.\begin{aligned} \left(D-\frac{2\pi eH}{ch}\right)f+\frac{1}{2}\frac{Ne^2}{mc^2}\frac{1}{r^3}(-iR_1g-R_2g+iR_3f)&=0 \\ \left(D+\frac{2\pi eH}{ch}\right)g+\frac{1}{2}\frac{Ne^2}{mc^2}\frac{1}{r^3}(-iR_1f+R_2f-iR_3g)&=0 \end{aligned}\right\}, (3)$$

In these D is the Schrödinger operator, written in the form of Dirac (*Proc. R. S.*, **112**, 661) with the view of relativity generalisation :

$$D=\nabla^2-\frac{1}{c^2}\frac{\partial^2}{\partial t^2}-\left(\frac{2\pi mc}{h}\right)^2+2\cdot\frac{2\pi i}{c^2h}\frac{Ne^2}{r}\frac{\partial}{\partial t}$$
$$+\frac{2\pi ieH}{ch}\left(x\frac{\partial}{\partial y}-y\frac{\partial}{\partial x}\right)+\left(\frac{2\pi Ne^2}{ch}\right)^2\frac{1}{r^2}$$

and

$$R_1=y\frac{\partial}{\partial z}-z\frac{\partial}{\partial y},\ R_2=z\frac{\partial}{\partial x}-x\frac{\partial}{\partial z},\ R_3=x\frac{\partial}{\partial y}-y\frac{\partial}{\partial x}.$$

N is the atomic number of the nucleus, and we have reversed Heisenberg's process of deriving Landé's doublet formula from the mean of $1/r^3$. As it will be needed later, we here note that with the present formulation the time occurs in f and g in the form $exp - i\frac{2\pi}{h}(mc^2+W)t$. In spite of their appearance the equations (3) are symmetrical in x, y, z, when $H=0$.

The presence of coefficients Nex/r^3, etc., is a strong invitation for us to generalise, since they are simply the electric forces. Moreover, this generalisation is required if we are to show that the anomalous Zeeman effect is the same phenomenon as the doublet effect We first split the two equations into four. Multiply by arbitrary constants a, b and add. Then do the same with ia, $-ib$; $-b$, a ; ib, ia. We call the quantities $af+bg$, etc., X_1, X_2, X_3, X_4. (The process is nearly, but not quite, the same as taking real and imaginary parts of (3).) The equations then become :

$$\left.\begin{aligned}DX_1-U_1X_4-U_2X_3+U_3X_2=0\\DX_2-U_2X_4-U_3X_1+U_1X_3=0\\DX_3-U_3X_4-U_1X_2+U_2X_1=0\\DX_4+U_1X_1+U_2X_2+U_3X_3=0\end{aligned}\right\}, \qquad (4)$$

where

$$U_1=\frac{1}{2}\frac{e}{mc^2}\left(E_y\frac{\partial}{\partial z}-E_z\frac{\partial}{\partial y}\right),$$
$$U_3=\frac{1}{2}\frac{e}{mc^2}\left(E_x\frac{\partial}{\partial y}-E_y\frac{\partial}{\partial x}\right)+i\frac{2\pi e}{ch}H_z.$$

These equations, which are really only two, are now in vector form for space transformations, regarding X_4 as a scalar and X_1, X_2, X_3 as a vector. We can therefore take the magnetic force in any direction by adding on to U_1, U_2 terms like the last in U_3. It remains to apply the relativity transformation. The first point to observe is that (4) is not in space-*time* tensor form. To make it so we must use the fact that with sufficient approximation $-i\frac{2\pi}{h}mc^2=\frac{\partial}{\partial t}$. Remembering that E_x is the 14 component of the force tensor, this shows that the equations must be put in the form

$$\frac{\partial}{\partial t}DX_1-V_1X_4-V_2X_3+V_3X_2=0,\text{ etc.}$$

where

$$V_1=-i\frac{\pi e}{h}\left(E_y\frac{\partial}{\partial z}-E_z\frac{\partial}{\partial y}\right)+i\frac{2\pi e}{ch}H_x\frac{\partial}{\partial t},\text{ etc.,}$$

This is now *dimensionally* a possible tensor equation, but is not in fact covariant for space-time transformations. It is necessary to take the electric terms in V to be twice as large as they really are ; this is exactly the trouble of Uhlenbeck and Goudsmit. We shall discuss it later, for the present simply doubling the first factor in V_1, etc. Now write $x_1x_2x_3x_4$ for x, y, z, ict, and ϕ_1, ϕ_2, ϕ_3, $-i\phi_4$ for the vector and static potentials ; also for the six forces put $F_{12}=\frac{\partial\phi_2}{\partial x_1}-\frac{\partial\phi_1}{\partial x_2}$, etc. Remembering that $\partial/\partial x_4$ is much larger than $\partial/\partial x_1$, etc., and that H is much smaller than E, we add on certain insensible terms and obtain as our final equations

$$\left.\begin{aligned}T_4X_1-T_1X_4-T_2X_3+T_3X_2=0\\T_4X_2-T_2X_4-T_3X_1+T_1X_3=0\\T_4X_3-T_3X_4-T_1X_2+T_2X_1=0\\T_4X_4+T_1X_1+T_2X_2+T_3X_3=0\end{aligned}\right\}, \qquad (5)$$

where

$$T_1=\frac{\partial}{\partial x_1}\left\{\sum_a\left(\frac{\partial}{\partial x_a}+i\frac{2\pi e}{ch}\phi_a\right)^2-\left(\frac{2\pi mc}{h}\right)^2\right\}$$
$$+i\frac{2\pi e}{ch}\left(F_{23}\frac{\partial}{\partial x_4}+F_{31}\frac{\partial}{\partial x_2}+F_{41}\frac{\partial}{\partial x_3}\right).$$

On the present view, apart from the introduced factor 2, these equations constitute the ultimate dynamics of a single electron. It will not alter the observed values, and will perhaps fit better with future generalisations if throughout (5) the operators $\partial/\partial x_1$, etc., are replaced by $\frac{\partial}{\partial x_1}+i\frac{2\pi e}{ch}\phi_1$, etc., as they are in D.

The first three equations of (5) are antisymmetric tensors of the second rank and the last is scalar, but the variables can be permuted according to the following scheme, so that any one of the four equations is the scalar :

$$\begin{matrix}X_1\\X_2\\X_3\\X_4\end{matrix}\rightarrow\left\{\begin{matrix}X_4\\X_3\\-X_2\\-X_1\end{matrix}\right.\rightarrow\left(\begin{matrix}-X_3\\X_4\\X_1\\-X_2\end{matrix}\right.\rightarrow\left(\begin{matrix}X_2\\-X_1\\X_4\\-X_3\end{matrix}\right), \qquad (6)$$

The existence of these permutations means that to regard the X's as a vector is an unnecessary restriction, to which it may not always be convenient to submit. For example, by allowing a different rule of transformation the theory could be put in terms of four purely real quantities.

We must next consider how the solution will go when more than one electron is present. This is a most important matter, for the replacement of independent by dependent variables might entirely alter the counting of the number of solutions. We shall omit relativity considerations and so may use (4) instead of (5). At first sight the most natural extension would be to regard X_1, etc., as functions of two sets of x, y, z ; thus the first equation of (4) would become

$$(D+D')X_1-(U_1+U'_1)X_4$$
$$-(U_2+U'_2)X_3+(U_3+U'_3)X_2=0.$$

The effect would be to double the number of solutions, but it would seem that they would sort out as $2+2$, not $3+1$ as is required. We need a process which will give $4+4$ solutions, reduced to $3+1$ by Heisenberg's resonance principle (*Zeit. f. Phys.*, **38**, 411). This could probably not be done for most vector waves, but the permutations (6) suggest a way out; for in combining the two sets of variables there is no particular reason to select the same permutation of both. The actual number of possible selections is easiest seen from (3), where in adding the effects together we can interchange the meanings of f and g. We shall in this way get two systems of equations each with four solutions, just the number required. The question of two or more electrons is, I think, the most serious difficulty for the present theory, and this is only intended as an incomplete and tentative suggestion as to how it may be met.

Finally, we must consider the factor 2 which had to be introduced to obtain the tensor form. This is evidently the original difficulty of Uhlenbeck and Goudsmit. It was removed by Thomas, who showed that a rigid body when accelerating exhibits a sort of rotation on account of the kinematics of relativity. This brilliant explanation resolves the disagreement, but it really imports a foreign idea into mechanics; indeed relativity and rotation do not take at all kindly to one another, and it is not surprising that no formal Hamiltonian method has been found to cover what is really a blemish in geometry rather than dynamics. As we here have nothing corresponding very exactly to velocity, we cannot use the same type of argument. But regarding the matter from a more abstract point of view, may we not perhaps draw an inference from the fact that our work has forced us to have equations of the third degree? Relativity is essentially a point theory and is governed by a quadratic form. To a first approximation motion is controlled by this form, and the associated wave equations are of the second degree. Now we have seen that the actual wave equations, though approximately of the second degree, are more accurately of the third. Taking the analogy back, may we not conjecture that the quadratic form of space-time wants amplifying in some way (I fear the idea is quite vague) by terms of the third degree, and that the reason why Thomas and Frenkel did not obtain a formal Hamiltonian is because 'quadratic' dynamics is only an approximation, which cannot be perfectly represented by importing into relativity theory the foreign idea of a rigid rotating body. But this speculation is too indeterminate to pursue further at present.

Nerves and Muscles: How we Feel and Move.

By Prof. A. V. Hill, F.R.S.

It is not an easy task to give the Christmas Lectures at the Royal Institution, especially on a subject like physiology, in which experiments are much more difficult than in some others, at least when required to work without fail, to be intelligible and not to cause offence. The difficulty is increased by the fact that one's audience does not consist simply, in the words of the Royal Institution, "of juveniles between the ages of 10 and 16"; one finds oneself addressing distinguished adults in many walks of life, and not only these, but also through the publicity given to these lectures in the press, a considerable proportion of the people of Great Britain. One must reflect, however, in preparing them that they are intended for 'juveniles,' and that if others dare to come they do so at their own risk and will be assumed to be 'juveniles' for the purpose of the lectures. It is true, as a matter of fact, that most lecturers are apt to pitch their lectures at a level much too high for their audience, and that by attempting to make them interesting to a child of thirteen they may well succeed in absorbing the attention even of adults comparatively expert in the matter with which the lecture deals. We all like to have things put to us simply, and no lecturer to a juvenile auditory should pay any attention whatever to people above the age of sixteen.

The Christmas lectures at the Royal Institution are intended to include a considerable number of demonstrations and experiments, and without the use of live animals experiments on the functional working of the body are impossible. Two fortunate facts, however, make it practicable to give suitable physiological demonstrations at the Royal Institution: (1) that the isolated organs and tissues of dead cold-blooded animals will continue to function for considerable periods after removal from the animal; and (2) that in recent years a great variety of perfectly good physiological experiments, often of precise quantitative as well as qualitative significance, have become possible upon men; and if upon men, then also upon children.

The fact that isolated tissues of animals will function for a long time after removal, although a commonplace of phsyiology, is not generally realised, and in itself is a matter of entrancing interest to those who come upon it for the first time: it awakens all kinds of questions, scientific and philosophical, which not only a 'juvenile' but also an adult urgently desires to see answered. The beating of an isolated heart, which will continue for hours or days after removal from its previous owner, provided that it be properly treated, is an extraordinary eye-opener to most people previously ignorant of phsyiology. There are few physiologists who do not remember the astonishment and interest which was aroused in them by their first sight of this phenomenon, or of the reflex movements of a frog whose head has been cut off, or of the contraction of a muscle preserved, sometimes for days, in salt solution; or of the electric current produced by an isolated nerve, or of the many other strange things that happen to little bits of tissue removed from the ordinary environment which their previous owner supplied. It is such things that bring physiology first into the region where exact experiments can be made, and allow the factors at work in living tissues to be examined carefully and at leisure in the laboratory. The astonishment which we, as physiologists, have felt at intervals at such things, and which, if we have not grown too old, we still remember, is one thing we can and should communicate to our listeners, not only perhaps at the Royal Institution, but also at our classes in universities. The experience of the lecturer himself, at such a course of lectures as these, is valuable as showing him the kind of thing that appeals to intelligent, keen, unsophisticated, and natural people. There was no doubt from their applause that the audience approved of experiments in which the functions of organs were revealed by such experiments on isolated tissues.

Even more, however, than experiments on surviving portions of dead animals did the audience appreciate the fact, which I am sure many of them had never realised before, that experiments of all kinds on the mechanism of the body can be performed on man, or in this case on children, without discomfort or danger. How many are the things which, when we were young, we wanted to know about the machinery inside which we live—and nobody told us. Gradually, perhaps, we thought that these things were not to be known, or were unknowable; gradually, perhaps, we reached the state, in which I fear a good many adults exist, of regarding the machinery of the body as something unwholesome or 'nasty.' If my audience had been simply one of adults, I might perhaps have been afraid of shocking them in taking a life-like model of a man to bits and trying to fit it together again, after describing its various parts. In the case of children no such fear is necessary. As I have already said, there are very few small boys and not many grown men who do not want to take machinery to bits to see how it works; and children are quite ready to realise that they live inside a mass of complex and beautiful machinery, and are only too glad to be given the chance of taking it to bits, at any rate scientifically speaking, and examining its parts.

To a child there is nothing 'gruesome' about seeing the heart beating in a live man, or in watching the food (by means of X-rays) travel along his inside; nor are they inclined to faint, as some adults are, if one amplifies the sounds made by a human heart, or shows a kinematograph film of the blood corpuscles swarming through the capillaries of the lungs The advantage of the audience at the Royal Institution is that they are natural people without any obsessions, so one can speak to them as one natural human being talking to another. Possibly some adults may have thought that the children *ought* to have been shocked by some of the experiments we performed; I am sure, however, that very few of the children themselves lived up to such an expectation. It is only by continually suppressing one's desire to know more about, and to understand, the body in which one has to make a home for so long, that one gradually develops an obsession that there is something unnatural, unclean, or 'gruesome' about it.

It was most instructive to note which of the demonstrations, and which of the lantern slides, appealed most to the audience. Of the slides the one that seemed to please the audience best was a simple little diagram, taken from Cannon, showing how the food is propelled along the alimentary canal by a peristaltic wave, consisting of a contraction behind and a relaxation in front of the portion of food to be moved. This little diagram evoked prolonged clapping. I suppose many of the audience had long wondered how the food moved along their insides, especially perhaps at Christmas time, and maybe had wanted to ask but had found nobody to tell them. Another slide they obviously admired was a simple diagram of the central nervous system, taken from Prof. Pear's book, "Skill in Work and Play," by which I described how they themselves, sitting up aloft in the cortex of the brain, were able to carry out all kinds of automatic, or semi-automatic, activity by means of the 'telephone exchanges' existing in the cord below, and were able to appreciate muscular movement by the messages from muscles, tendons, and joints which pass up along the afferent nerves and into the different levels of the nervous system. Another slide which evoked obvious approval was a simple piece of arithmetic by which I explained how the greater the length of a race the slower one had to go. This is a fact of which we are all aware, but only recent progress in physiology has made clear what are the factors which determine it. The body has a certain 'income' of oxygen and a certain 'credit' upon which it can draw. If the 'credit' has to spread out over a longer period, less of it can be spent per minute, the effort must be smaller, and the speed lower. The fact that they obviously approved of this simple arithmetic, which certainly contained nothing sensational or dramatic, is a tribute to the intellectual level of the audience.

The first lecture dealt with "Nerves and the Messages they Carry." Isolated nerves and muscles were shown working, the electric current produced by an excited nerve was demonstrated, and an experiment was made on the stimulation of the ulnar nerve of a child. The messages coming along nerves were described, and the central nervous system was likened to an automatic telephone exchange.

The second lecture dealt with "Muscles and How they Move." In this, isolated muscles were stimulated, and a competition was organised between the muscle-nerve preparation of a frog and the muscles of a child stimulated through the ulnar nerve. The child won easily, because his circulation was able to supply his muscles with the oxygen they required in order to do the work, while physical diffusion alone was unable to bring oxygen rapidly enough to the frog's isolated muscle, which therefore rapidly fatigued. The electric change of the human heart was shown, and the physical and chemical basis of fatigue was discussed.

The third lecture dealt with "The Heart and Some other Muscles," chiefly with the heart. X-ray pictures of the alimentary canal after an opaque meal were followed later by a demonstration, kindly organised by Messrs. Watson and Sons (Electro-Medical) Ltd., in which a subject drank an opaque meal, which could be observed passing down into his stomach. Following this was an X-ray demonstration of the heart of the lecturer and others. The lecture had been started by a demonstration, organised by the Marconiphone Company, Ltd., in which the sounds made by the heart of a child were rendered audible throughout the hall. In the fourth lecture I dealt with "The Lungs and Blood: How the Muscles get Air and Fuel," in which perhaps the chief demonstration was that of a wonderful kinematograph film by Prof. Krogh, of Copenhagen, in which the blood corpuscles are seen circulating in the tissues of a frog. There is no means of which I am aware so good as this film of showing what the circulation of the blood really means. We discussed the energy derived from the fuel burnt in the muscles, and we saw experimentally how the oxygen consumed by man can be measured.

In the fifth lecture, "Nerves and Muscles Working Together," I discussed the basis of organised muscular movement, the nature of muscular skill and of muscular sensation, and all those automatic, or semi-automatic, actions of which a large part of our being is composed. A slow motion kinematograph film of a dancer, and another of a falling cat, were employed to emphasise the wonder of muscular skill, while a demonstration of the 'psycho-galvanic reflex' showed how our emotions cannot be hidden from certain quite simple physical apparatus. The sixth lecture, "Speed, Strength, and Endurance," dealt with an application of some of these matters to such things as mountain climbing and athletics; the importance of an adequate supply of oxygen was demonstrated by an experiment on a boy who pedalled a bicycle, breathing oxygen at only two-thirds of the ordinary atmospheric pressure, until very tired, and was almost immediately relieved—and pedalled with renewed vigour—when given oxygen in high concentration. Finally, it was emphasised how a capacity for severe muscular effort depends mainly on simple considerations of energy, and of skill in the economy of energy, and how certain predictions can be made of a man's athletic capacity by means of physiological measurements.

As I said in my first lecture, many people who own motor-cars know very little about the insides of them and how they work, which is distressing enough, especially when they go wrong. How many more who own perfectly good bodies have only the vaguest idea of their machinery, or of the meaning and importance of the various parts. In these lectures I tried to give my audience some idea of the working of two of the most important parts of the body. One cannot hope yet to understand our living machinery in full, but even the little we know already can add delight to physical exertion, and can make us realise the complexity of muscular skill and the nature of strength and endurance. The effort to understand will help us to appreciate the beauty and wonder of the devices with which our bodies are endowed; and when we begin to understand a little we shall soon want to understand much more.

Obituary.

Dr. Eugen Hultzsch.

By the death at Halle on Jan. 16, in his seventieth year, of Eugen Hultzsch, the study of Indian epigraphy loses one of its most ardent and painstaking followers. Born in Dresden, he was educated at Leipzig and Bonn, studying under Aufrecht, the famous Sanskritist. From 1882 until 1886 he was assistant professor of Sanskrit at Vienna. He was then appointed epigraphist to the Indian Government, remaining in the Service until 1903, when he retired and accepted the chair of Sanskrit at Halle. This he held until his retirement some time after the War. During the greater part of his service in India, Hultzsch edited *Epigraphia Indica*, to which he contributed many valuable articles. His own researches were very largely devoted to the inscriptions of the Presidency of Madras. His "South Indian Inscriptions," published between 1890 and 1893, gave in three volumes critical texts and translations of between three and four hundred inscriptions, mostly from the Tamil country. His reports on Sanskrit manuscripts in southern India were published in three massive parts between 1893 and 1905. His reputation as a scholar, however, will rest mainly on his edition of the edicts of Asoka—a subject on which he was the acknowledged authority. The publication of this standard work was delayed by the War, but it has recently been issued by the Indian Government on behalf of the Archæological Survey. In it the whole of the previous literature of the subject is critically examined, and each text is given in the original with an English translation. Hultzsch was a contributor to the *Journal of the Royal Asiatic Society* and to that Society's prize publications, as well as to other orientalist periodicals, while in recent years he took a prominent part in the work of the German Oriental Society. Orientalists in Britain are particularly indebted to him for, first, the valuable collection of Sanskrit and other manuscripts made during his stay in India which is now in the Bodleian Library at Oxford, and, secondly, for his exertions in securing the return to the India Office and the Royal Asiatic Society of the valuable manuscripts and books on loan at the Leipzig exhibition when the War broke out.

We regret to announce the following deaths:

Sir George Greenhill, F.R.S., formerly professor of mathematics in the Artillery College, Woolwich, on Feb. 10, aged seventy-nine years.

Dr. C. D. Walcott, secretary of the Smithsonian Institution of Washington, D.C., since 1907 and formerly director of the U.S. Geological Survey, on Feb. 8, aged seventy-six years.

News and Views.

Greek philosophers twenty-five centuries ago held that the gods work by geometry and by arithmetic: mathematics is the corner-stone of the temple of science. During the past two years a remarkable development has taken place in theoretical physics through the application of mathematical methods to the problems of the quantum. The introduction of the new quantum mechanics associated with the names of Heisenberg and of Schrodinger, and the revival of interest in the spinning electron, bid fair to initiate a new era in quantum theory. It is a striking testimony to the powers of generalisation inherent in mathematics that the method of matrices, due originally to Cayley, has proved a useful weapon of attack in the hands of Born and Jordan. After a prolonged discussion of the relative merits of language and mathematics as elementary disciplines, Willard Gibbs is reported to have said: "Mathematics is a language." Unfortunately it is too frequently "a tongue not understanded of the people," and for that reason it is not now our usual custom to publish in Nature articles involving advanced and unfamiliar mathematical methods. The present stage of development is, however, exceptional, and as many of our readers are deeply interested in the new ideas, we have to some extent departed from precedent and are publishing certain articles by eminent authorities in which mathematical treatment is a necessity.

In our present issue Prof. C. G. Darwin discusses the nature of the electron; after pointing out certain difficulties which arise on the hypothesis of the spinning electron, he suggests that the electron should be regarded as a system of waves of a vector character though not transverse. In treating the electron as a vector wave, he finds himself faced with a difficulty which arose also in the work on the spinning electron. A factor 2 has to be introduced to obtain the requisite results, and Prof. Darwin suggests that the quadratic form of space-time wants amplifying in some way by terms of the third degree. Perhaps a guess may be hazarded that the difficulty arises from insufficient attention being paid to the possible existence of 'magnetism' as essential to the constitution of the fundamental units of electric charge. But whatever may be the final reading of the riddle, our readers will welcome the attempts which are now being made to solve these and other fundamental problems in atomic physics.

The Prince of Wales was the principal guest at the annual dinner of the Institution of Electrical Engineers on Feb. 10. In proposing the toast of the Institution he mentioned that after his presidential address to the British Association last year, Lord Balfour had expressed the hope that his year of office would be marked by some striking scientific achievement. This has now been accomplished. By the labours of the experts in Great Britain and the United States, the Atlantic has been finally bridged by radio telephony, and to-day anybody in Great Britain can—at a price—call up anybody in America whenever he cares. The Prince reminded his hearers that the scientific machine is always running quietly in the laboratory. Individual effort by itself will not keep this machine running smoothly. Were it not for the existence of our various scientific and technical institutions it might even come to a standstill. The Institution of Electrical Engineers bridges the great gulf between pure science and practical science. Electricians have given to the community electric light, power, and radio. Their inventions are known throughout the world and in every home at the present time. Great Britain would be in a very bad way if it did not back up inventions. We are perhaps a little too apt to be afraid of new things. Dr. Eccles, the president of the Institution, in replying, said that the Institution numbers nearly 18,000 members, and is in close touch with every electrical activity in the country. The signals from the radio station at Rugby are received all over the globe, and measurements show that they are the most powerful signals in the world. The Rugby station and the beam stations in Britain are in advance of foreign practice. Last year Englishmen laid in the Pacific the longest submarine cable in the world constructed with all the latest improvements. Col. Wilfred Ashley, the Minister of Transport, said that the Electricity Act caused members of the Government a good deal of trouble last year; one effect of the Act being before Parliament, however, is that the manufacturers of Great Britain exported £20,000,000 worth of goods overseas during its discussion.

The gold medal of the Royal Astronomical Society has this year been awarded to Prof. F. Schlesinger for his work on stellar parallaxes and the determination of star places and proper motions by photography. Dr. J. H. Jeans devoted his presidential address to the Society on Friday last, Feb. 11, to a survey of this subject. Prof. Schlesinger's work on parallax began very early in the century. At that time only about eighty stellar parallaxes had been determined, and many of them were very uncertain. He published an article with several valuable suggestions for the improvement of photographic determinations. The two most important points were: (1) The light of the parallax star must be equalised with that of the comparison stars; this can be done either by placing a semi-transparent screen over the lighter image, or preferably by rotating a circular disc, from which a sector has been cut out, in front of it; (2) in order to eliminate differential refraction depending on colour, all plates must be taken close to the meridian, and the measures made in the direction of Right Ascension. Prof. Schlesinger carried out these principles first at the Yerkes Observatory, and later at Allegheny. He himself has obtained several hundreds of parallaxes, with probable errors in the neighbourhood of one-hundredth of a second of arc; many observatories, including Greenwich, have followed in his footsteps, so that the number of known parallaxes runs into thousands.

Another line in which Prof. Schlesinger has done most useful work is the application of doublet lenses to stellar photography. He has shown that accurate stellar positions can be obtained on plates covering an area of 5° × 5°; in spite of the smaller scale, the precision of the measures is practically equal to that obtained with the astrographic telescopes, while the area of the plates is six times as great. He has already published catalogues for two complete zones, and the results are so successful that the Astronomische Gesellschaft has made arrangements to survey the whole of the northern heavens in a similar manner in the course of the next few years. Prof. Schlesinger is now director of the Yale Observatory; he is continuing work on the lines that he followed at Allegheny, and visited Johannesburg early in 1925 to inaugurate the work of the telescope that was sent there from Yale, which is in charge of Dr. Alden.

Homage was rendered to the memory of the late Prof. Heike Kamerlingh Onnes on Feb. 10, when Prof. Ernst Cohen, of the University of Utrecht, delivered the Kamerlingh Onnes Memorial Lecture before the Chemical Society. The address was a panoramic survey of a fruitful life rather than an analysis of the theoretical and experimental achievements which entitle their author to be numbered among the *primi inter pares* for all time. Prof. Cohen first referred to the records of Kamerlingh Onnes' schooldays under Van Bemmelen, later professor of chemistry in the University of Leyden; to the award at eighteen years of age of a gold medal for an essay on "A critical investigation of the methods of determining the vapour density, and of the results obtained thereby, with respect to the relation of the nature of the chemical compounds and the density of their vapours"; to his sojourn at Heidelberg with Bunsen and Kirchhoff; and also to his sterling personal qualities. Onnes' doctorate thesis, presented at Groningen in July 1879, insisted on the closest correlation between theory and experiment, a programme to which he adhered to the end of his days. In Oct. 1882, when assistant in Bosscha's laboratory, he was appointed to succeed Ryke as professor of experimental physics at Leyden; simultaneously there commenced his triumphal progress through the realms of low temperatures.

Of Dewar and other workers in the same domain, "le gentleman du zéro absolu" with "Inferior!" as his watchword, continually spoke in appreciative recognition; neither did he neglect to acknowledge the part which his wife (Elisabeth Byleveld, whom he married in 1887) had played in his success by her care for her delicate husband. On Dec. 10, 1913, he received the Nobel Prize at the hands of the King of Sweden. In speaking of Onnes' character as a man and as an investigator, the lecturer referred to the report of the solidification of helium in March 1908, quickly followed by letters to Nature in April (vol. 77, pp. 559 and 581) withdrawing the announcement and ascribing the observations to solution phenomena of solid hydrogen in gaseous helium renewed experiments yielded liquid helium in the following July. In 1922 Onnes considered it safe to say that "the lowest temperature yet attained is some hundredths of a degree below 0·9° Abs." On Feb. 21, 1926, he passed away, leaving the last stage of his work on helium to be completed, but a few months afterwards, by Keesom. Prof. Cohen briefly referred to Onnes' services to the craft of instrument making, and concluded his tribute with words borrowed from Prof. Donnan: "He was a gentleman in every sense of the word, and one of the first gentlemen of European Science."

Believers in democratic institutions will watch with great interest the development of the Fundamentalist controversy in the United States, which is far from being the Gilbertian drama which it is sometimes taken for in England. The dictatorship of the uneducated and mentally undeveloped is a very real menace in the middle western and southern States of the Union. We have received a pamphlet, "Evolution and Intellectual Freedom," compiled by the Rev. Dr. Hay Watson Smith, pastor of the Second Presbyterian Church in Little Rock, Arkansas, in view of a threat to prohibit the teaching of the theory of evolution in the tax-supported schools of the State. The pamphlet contains a number of representative pronouncements of American and British men of science, as well as expressions of opinion by Theodore Roosevelt and Woodrow Wilson. In all probability these authoritative utterances will enliven the virulence of the anti-evolution fanatics; for if the doctrine is so well supported, there is all the more need to suppress it. How the fight will end it is impossible to say. Truth prevails, of course, but only with the intelligent, who must be in a very small minority in the State of Arkansas. We cordially admire the courage and vigour of Dr. Hay Watson Smith, and the ability displayed in this compilation of his. It is always so easy to fall in with the majority, and so difficult, in a country like America, where opinion is so much less free than in Europe, to take an independent line.

That Dr. Hay Watson Smith's pamphlet has not yet been effective is evident from a message in the *Times* of Feb. 11, in which its New York correspondent reports that the Arkansas House of Representatives has just passed a Bill prohibiting the teaching of evolution in any school supported by taxation. The Bill indeed passed by a narrow majority, 50 votes to 47, and had actually been defeated on a first roll-call. A similar Bill was 'killed' in committee by the New Hampshire legislation and by that of Missouri. In Louisiana, however, in spite of an adverse vote by the legislature, the Superintendent of Schools has, on his own authority, acting under pressure from religious associations, directed that evolution shall not be taught in State-supported schools. One wonders whether the science teachers are sufficiently well organised to resist this sort of dictation. Obviously, argument and appeals to reason are likely to be in effective, and only co-operative action, whether by passive resistance or otherwise, can avail. Yet the Fundamentalists are one of the most powerful, as they are the most ignorant, sections of opinion in America. Science teachers and, indeed, all who desire progress, will, therefore, have to exert themselves very actively if they are to survive in this struggle for free intellectual existence.

In his fourth Gifford lecture in the University of Edinburgh, delivered on Feb. 11, Prof. A. S. Eddington discussed the extension of the theory of relativity to non-uniform motion made by Einstein in 1915, ten years after the announcement of his earlier hypothesis. Prof. Eddington described the curious effects which would be observed when performing simple experiments within a freely falling lift, and the different views as to the results which observers inside and outside the lift respectively would record. Their experiences necessitate the re-formulation of the law of gravitation to include some conception of curvature. Space-time is now regarded as a four-dimensional manifold, and it requires twenty distinct measures at each point to specify it. Ten of these measures are more prominent than the rest, and Einstein's law of gravitation asserts that in empty space these ten principal measures of curvature are zero. A fundamental point in the theory is the relativity of acceleration.

Mr. W. H. Brown, Mill Hill School, London, N.W.7, recorded in last week's issue (p. 238) that two-way communication had been established between the School and the two Norwegian whalers *Sir James Clark Ross*, call-sign AQE, and the *C. A. Larsen*, call-sign ARDI. He now informs us that Mr. C. W. Goyder listened-in from the Mill Hill School station 2SZ) at 8.15 A.M. on Feb. 13, when he found that AQE was already in communication, in Norwegian, with LAIX (J. O. Berven, Stavanger). In reply to various questions, AQE reported to LAIX that signals were being received well, and that the ship had been in direct communication with LGN (the Bergen Radio Coast station) during the week. Mr. Goyder has heard another English station, 2LZ (F. A. Mayer, Stileman's, Wickford), in two-way communication with ARDI. It appears, therefore, that such communication with two ships in the Antarctic has now been established between two Norwegian and two English stations.

Dr. E. F. Armstrong, managing director of the British Dyestuffs Corporation, in his address before the Royal Society of Arts on Feb. 9 on "The Romance of the Organic Chemical Industry," selected the aliphatic alcohols as providing examples of chemical achievement of great industrial importance. Ethyl alcohol, used as a solvent and as an anti-freezing agent in the radiators of motor-cars, is made in large quantities from molasses. Its manufacture by an alternative method, the conversion of cellulose, for example, sawdust into fermentable sugar, Dr. Armstrong described as one of the prime problems of chemical industry to-day. By the synthetic production of methyl alcohol the cost has been reduced to about 20 per cent. of what it used to be. In due course the way is clear to cheaper formaldehyde and consequently cheaper indigo and synthetic resins. Butyl alcohol is being made in thousands of tons from grain or rice; but another process is also in use, based on acetylene. Yet another potential source is petroleum. In general, the tendency in the production of alcohols is to substitute methods based on coal or carbide for fermentation processes using food-stuffs. Dr. Armstrong concluded an interesting address with an appeal for more research directed to finding out how to accomplish new things, or even old things in a novel manner.

Prof. Edmund Gardner delivered a lecture on Feb. 8 on "Conceptions of the Cosmos, according to Dante," in continuation of the series which is being given at Bedford College for Women (University of London). He stated that Dante's cosmology is based ultimately on Aristotle, but as modified by Christian conceptions of the relationship of the universe to its First Cause. His individuality lies in his mystical interpretation of generally received theories. In Nature, "the Art of God," the soul may contemplate the working of the Divine Will. It has a threefold existence, in the mind of the First Mover, in the heavens, in the world of created things. The earth lies at the centre of the universe, disposed in nine concentric spheres revolving round it. Universal Nature originates in the ninth sphere, that of the First Mover, which by its motion regulates the motions of the other eight spheres. Enveloping the whole is the tenth sphere, or Empyrean, where there is neither time, space, nor natural law. The universe is brought into being by a process of double creation. The angels, the soul of man, the heavens are created immediately; secondarily, through the agency of Nature, there is a continuous process of generation by which potential matter becomes actual existence. The four elements, fire, air, water, earth, are disposed in concentric circles, earth being at the centre. But because universal Nature required a place where the elements could meet in order that things might come into specific being, portions of earth have been raised above the water. This, the inhabited earth, is confined to the northern hemisphere, and Jerusalem is its centre. At the antipodes lies the Mountain of Purgatory. The informative virtue of the heavens in the motion of the spheres superimposes form on the substratum of primal matter. The imperfect result is due not to the agent, but to a flaw in the material owing to the mysterious presence of evil. The whole creation is a single order through the working of a spiritual law of gravitation. An instinct is given to each thing to realise the degree of perfection of which it is capable, and to move to its own place where it is at rest. All causes are traceable to the First Cause; the universe is a unity.

Every one who has studied mechanics has a wholesome dread of high-speed machinery. In a 25,000 horse-power electric generator driven by a water or steam turbine and running at 3000 revolutions per minute, the rotating part weighs about 20 tons and the kinetic energy is about 50,000 foot tons. In fact, the energy is approximately the same as that developed by a head-on crash between two fourteen coach six hundred ton trains each travelling at 35 miles per hour. The bursting of a rotor running at this speed might well cause a serious loss of life as well as great damage to property. In practice the stresses are all computed beforehand and a large factor of safety is allowed. Only the highest class material is used, and the greatest possible care is taken in manufacture. In addition, the completed machine is usually tested in an underground pit. The Metropolitan Vickers Electrical Co. of Manchester has recently designed and erected a new ‘overspeed’ test house in which ‘rotors’ up to 14 ft. 6 ins. in diameter and shafts up to 40 ft. in length can be tested. The walls are 9 ft. 6 ins. thick and are composed of wood, steel, bags of sand, air-cushioning space, and reinforced concrete. In arranging the materials, advantage was taken of the lessons learned during the War in the construction of shell-resisting structures: the door alone weighs 17 tons. A motor of 1800 horse-power is installed permanently, and by suitable gearing, speeds ranging from 350 rev. to 7200 rev. per min. can be attained. Special arrangements can also be made to attain much higher speeds. When the rotor to be tested is fixed in position, the door of the test-house is closed and complete control is obtained by electrical means. Vibrographs, oscilloscopes, and high-speed cameras are employed and elaborate records are made. In addition, a hole is bored right through the centre of the shaft and the internal surface is carefully inspected by a specially designed telescope.

During the oceanographical expedition of the *Arcturus* in July 1925, a Petersen trawl was worked on the edge of the Challenger Bank (about 10 miles south-west from Bermuda), and at a depth of about 506 fathoms, in a region where the sea bottom rapidly slopes down to more than 2000 fathoms. In the catch made were four eggs of about 3·3 mm. in diameter. Their appearance was that of the eggs of eel-fishes that are known, but there was only one way of identifying the species to which they belonged—that of hatching them out. Fortunately this was successfully done, and in a preliminary note (*Science*, Nov. 5, 1926) Marie Poland Fish describes the larvæ that were so obtained. There seems to be little doubt that they are leptocephali of the American eel, *Anguilla rostrata*. Pelagic nets were being worked both at the surface and at various depths, while the Petersen trawl was at the bottom, but only in the latter instrument were eel-eggs obtained. It is suggested by the author that the observations favour the previous theory of deep fertilisation. The catch was made within the boundary of the region regarded by Johs. Schmidt as the breeding ground of the American and European eels. Few observations will give naturalists so much pleasure as this: since 1904, Dr. Schmidt has carried on his intensive study of the life-history of the eel, and a year ago the only essential observation that had still to be made was that o finding the eggs. Details are yet to be worked out but with this record there ends a mystery that ha perplexed naturalists since the time of Aristotle, an a word of congratulation to Marie Fish and Johs Schmidt is not inappropriate.

The sixth annual report of the British Electrica and Allied Industries Research Association, presente at the meeting on Feb. 11, is of interest, as it show that electrical manufacturers are keenly alive to th importance of scientific research. As a rule th research work undertaken by private firms is confine to that which yields immediate results commercially But there is a large section of the work which demand intensive co-operative effort on the part of all section of the industry, and in this direction research associations can do useful work. During the past year a attempt has been made to unravel the complicate physical phenomena which cause the breakdown o electrical insulation. Considerable progress has bee made in explaining the phenomena as shown by gases and it is hoped that the vexed questions of the breakdowns in liquids and solids will soon be satisfactoril answered. In particular a study of the coron phenomena in liquids is furnishing data of importanc to designers. Working pressures are still on th upward grade and accurate and simple methods o measurement are required. A useful critical résum of recent work on dielectrics has been prepared b Mr. L. Hartshorn of the National Physical Laboratory Enlarged tables have been issued during the yea based on the experimental work previously complete by Prof. H. L. Callendar. The work has been extende to higher temperatures and pressures and the apparatu constructed is expected to give results up to a temperature of about 850° F. and steam pressures o about 3000 lb. per square inch. The results give have proved useful to the designer and form a trustworthy basis for the rating of turbines.

The formation of Imperial Chemical Industries Ltd., a combination of four of the most importan chemical concerns in Great Britain, namely, Brunne Mond and Co., Ltd., Nobel Industries, Ltd., Britis Dyestuffs Corporation, and United Alkali Co., Ltd. is of high significance in its bearing upon chemica research in Great Britain. The larger an industria corporation grows, the more time can it afford t spend on research of an academic nature, because it results are available to a larger public. It is commo knowledge that some of the constituent firms of th above combination have already made substantia contributions towards the discovery of new knowledge of a general type, and the advances made i this direction are an earnest of substantial contributions from industry to science to be expected in th future. Most research work in chemistry carried o at universities and similar institutions is limited t conditions of easily obtainable temperatures an pressures, on account of lack of money, lack o continuity of research staff, and the necessity o doing research which will ‘come out’ in a reasonabl time.

A great combine such as Imperial Chemical Industries, however, has great advantages: it is endowed with ample funds, has plenty of time and a continuity of staff, and is therefore able to attack problems which are beyond the scope of most universities. Whether the results of such work will be suitable for publication, and whether it will be published, remains to be seen. Much scientific research of this kind is concerned with the determination of as many physical constants as possible, because they can be applied later to other problems. That these determinations will be carried out with the greatest accuracy possible is also certain, in order to make the work permanent and of real capital value. We may be sure, therefore, that the well-known research tendencies of some of the constituent companies will be intensified in the allied group. The effect of this on academic life will be all to the good, and the study of the theoretical sides of somewhat neglected branches of science will be promoted. In short, it is not too much to hope that the effect of the research policy and publications of the new combine will give to academic chemistry a healthy stimulus and direction which should be of benefit to both science and industry.

It is some twenty years since the New Zealand government began its policy of acquiring lands for the sake of preserving natural scenery. From a small beginning the area of scenic reservations in the Dominion has now grown to 454,000 acres. The recent annual report of the Department of Lands and Survey on scenery preservation records the addition during 1925–26 of 3067 acres. These include an area surrounding the Wairoa Falls which will ensure the safety of the falls and a stretch of native bush; a kauri forest of 652 acres on the Waitakerei ranges, where bird life is abundant; an area of 19 acres of the limestone rocks of Waro; and several other areas valuable on account of their wild life or proximity to well-settled districts. Part of Motuanaura Island on Queen Charlotte Sound was reserved on account of its historic interest, since it was there that Captain Cook in 1770 proclaimed British sovereignty over the South Island.

The Smithsonian Institution, Washington, has just received from M. Ferdinand Canu, of Versailles, a leading authority on fossil micro-organisms, his collection of fossil invertebrates from France, and particularly the Paris basin, that he has spent fifty years in gathering together. The collection is accurately labelled as to the localities and geological horizons whence the specimens came. M. Canu chose the Smithsonian as the depository of his collection to secure its preservation and to insure its immediate use in connexion with the recently discovered relationship between fossil micro-organisms and oil deposits, a field in which associates of the Smithsonian Institution were among the pioneers. M. Canu made the gift through Dr. R. S. Bassler, palæontologist of the National Museum under the Smithsonian, with whom he has collaborated extensively since 1910 in working out geological horizons for the Atlantic and Gulf States. This work was undertaken by Dr. Bassler and M. Canu at the request of the U.S. Geological Survey. In 1924 M. Canu received the Elliot medal, one of the highest honours in American science, from the National Academy of Sciences for his work in palæontology.

With the December number our Norwegian contemporary *Naturen* completed its fiftieth year. A retrospect of the valuable popularising work it has accomplished since its foundation in 1876 by the geologist, Dr. Hans Reusch, is given by Dr. W. C. Brøgger. The number also contains an article by Lektor O. Valeur on the theory of relativity and its effect on our conception of the universe. Continuing his articles on the food of the East, Dr. Sopp here describes *ching-tong*, a Chinese malt-extract prepared from rice and used for many dietetic purposes. A note on lemming, by J. Grieg, and other small notes complete the number. We offer our congratulations and best wishes for the future to the present editorial staff.

The Report of the Bristol Museum for the year ending Sept. 30, 1926, records the gift by Lord Ducie of the collections formed at Tortworth Court by the third Earl of Ducie. These include a unique fauna from the Llandovery and Wenlock rocks of Tortworth, with good series from the older rocks of South Wales and the Carboniferous Limestone of Belgium, also more than two thousand stone implements from the British Isles and Europe, and ethnological specimens from New Guinea and North America. Another important accession is the collection of birds and mammals obtained by Sir J. H. Greville Smyth, Bart., preserved at Ashton Court and in the Bungalow, Ashton Park, and now presented by the Hon. Mrs. Esmé Smyth. It is expected that the extension of the Museum and Art Gallery, provided for by the generosity of Sir George A. Wills, Bart., will be completed in two years.

In the Report of the Executive Committee of the Empire Cotton Growing Corporation, submitted on Jan. 13, mention is made of the Report of the Research Sub-Committee set up by the Imperial Conference, which, after referring in eulogistic terms to the work of the Corporation, recommended the Conference to pass a resolution commending to the various Governments the work of the Corporation in the promotion of Empire cotton-growing. It also recommended periodical agricultural conferences, the first to be in London in 1927, and invited all the Governments concerned to send representatives. The Director of the Corporation is about to start upon a visit to South Africa, where, under plantation conditions, the present low price of cotton is a serious handicap. Rain-grown cotton is being successfully extended in the Sudan, and notice is taken of successful work going on in many parts of Africa, especially of Mr. Sampson's activities in work upon rotation of crops, a thing which is eminently desirable in connexion with Empire cotton.

The Société de Biogéographie, Paris (61 rue de Buffon), is now entering into the fourth year of its existence and we are asked to invite the attention of all botanists, biologists, ethnologists, geologists and zoologists, whose aim is the study of the distribution of living and fossil organisms over the surface of the globe, to this association. The society meets every month, and useful and interesting discussions on various subjects are held. In addition, at fixed intervals it institutes fundamental investigations on subjects selected as of importance to biogeographers, the solutions of which may require the collaboration of specialists in various branches of knowledge; for example, a series of memoirs forming a volume of 250 pages has lately been prepared on the "Histoire du Peuplement de la Corse"; a new volume on "Le Peuplement des Montagnes" is in preparation. The number of the members of the society is limited; but its reports (*Compte rendu Sommaire des Séances de la Société de Biogéographie*) for the years 1924–26 are on sale; current reports can be subscribed for (15 francs a year for France and 18 francs for abroad).

The new journal *Protoplasma* or the *International Journal of the Physical Chemistry of Protoplasm*, which has recently been founded in Austria under the editorship of Prof. Weber of Graz and Prof. Spek of Heidelberg, seems to be thoroughly justifying its existence. There has certainly not been, up to the present time, any journal devoted to the physics and chemistry of the cell-interior—to physico-chemical cytology. In the first number, W. Seifriz investigates the protoplasmic papillæ on the surface of the immature sea-urchin egg and discusses their colloidal nature. E. Küster writes on plasmolysis and gives details of his experiments on *Vakuolenzerklüftung*, and much the same subject is treated by W. Beck, who deals with sucrose and nitric acid as plasmolysing agents. B. Ephrussi has a very interesting paper on the temperature coefficients of the different phases of the mitosis of the sea-urchin egg, which he compares with others previously determined for the cleavage of Ascaris eggs. J. Gicklhorn's review deals with the importance of the dielectric constant in microbiology. Two bibliographies are given, one on recent work with ray effects on protoplasm, and the other with the viscosity of protoplasm, and the number is very well illustrated. The second number contains papers by F. Vonwiller on microscopical technique, G. W. Scarth on permeability in Spirogyra, and M. M. Brooks, also on cell-permeability. A. Rumjantzeff and B. Kedroffski contribute a paper with some beautiful plates on vital staining in protozoa, Y. Kuwada and T. Sakamura another on the colloidal chemistry of chromosomes, and G. Ettisch and A. Szegvari a third on the structure of connective tissue fibrils. Finally, there is a review by J. Needham and D. M. Needham on the oxidation-reduction potential of the cell-interior. In both issues there are a valuable series of reviews of books, and abstracts of the more important current original investigations. Without a doubt the new journal will fill a distinct gap in scientific periodical literature.

At the annual general meeting of the Royal Astronomical Society, held on Feb. 11, the following officers were elected: *President*, Rev. T. E. R. Phillips; *Vice-Presidents*, Sir Frank Dyson, Prof. A. S. Eddington, Prof. A. Fowler, and Lieut.-Col. F. J. M. Stratton; *Treasurer*, Mr. P. H. Hepburn; *Secretaries*, Dr. J. Jackson and Dr. H. Knox-Shaw; *Foreign Secretary*, Prof. H. H. Turner.

At the meeting of the Royal Microscopical Society held on Jan. 19, the following officers were elected: *President*, Dr. J. A. Murray; *Vice-Presidents*, Mr. A. Chaston Chapman, Dr. C. Da Fano, Dr. J. W. H. Eyre, The Hon. Sir Charles Parsons; *Treasurer*, Mr. C. F. Hill; *Secretaries*, Mr. J. E. Barnard, Dr. Clarence Tierney; *New Members of Council*, Mr. J. G. Bradbury, Dr. W. E. Cooke, Mr. M. T. Denne, Dr. J. C. Mottram; *Librarian*, Mr. S. C. Akehurst; *Curator of Instruments*, Mr. W. E. Watson Baker; *Curator of Slides*, Mr. E. J. Sheppard.

The annual general meeting of the Institute of Metals will be held on Mar. 9 and 10 in the hall of the Institution of Mechanical Engineers. The first morning will be devoted to papers on the effect of arsenic and bismuth on the properties of copper, and the afternoon to a paper on electric furnaces in non-ferrous metallurgy; the papers for the morning of Mar. 10 deal with the penetration of solders and the study of eutectic alloys, and those for the afternoon with magnesium, aluminium, and other alloys, and early brass and lead. The annual dinner will be held on the evening of Mar. 9.

A useful adjunct to the botanical teaching in the schools of Reading has been provided by Dr. J. B. Hurry, who has presented a well-stocked economic botany collection, which has been organised as a department of the general museum of the borough. The specimens are classified into: miscellaneous food products, nuts, fibres, woods, gums and resins, medicines, and dyes. Pupils will thus be enabled to turn aside for a space from the more academic aspects of botany and study a branch of the subject too often neglected in schools—the origin and production of some of the common substances of domestic and industrial usefulness.

The latest catalogue (No. 491) of Mr. F. Edwards, 83A Marylebone Road, W.1, should be of great interest to many readers. It gives the titles, and in some cases particulars, of upwards of 1600 works relating to the origin and history of man, classified under the headings of anthropology, etc., Buddha and Buddhism, folklore, freemasonry, gipsies, and witches and witchcraft. The catalogue can be obtained free upon application to the bookseller.

The Section of Terrestrial Magnetism of the International Union for Geodesy and Geophysics has issued a "Preliminary Report on Subjects of Investigation." The matters discussed include comparisons of magnetic instruments (L. A. Bauer), magnetic characterisation of days (A. Crichton Mitchell), terminology in terrestrial magnetism and electricity (C. Maurain), the measurement of sudden commencements of magnetic storms (A. Tanakadate), the study of magnetic rocks *in situ* and in the laboratory (L. Palazzo), crucial phenomena of polar lights (C. Størmer), and thunderbolts (E. Mathias).

We have received "A Guide to British Spas and Climatic Health Resorts," 1927, which is published by Messrs. J. and A. Churchill, 7 Great Marlborough Street, W. (1*s*. net). Detailed information is given of the situation, climate, bath establishments, and characters of the waters of the British spas, and of the class of cases likely to be benefited thereby. Information is also given respecting the principal British health resorts other than spas. Lists of hotels, hydros, and other residential accommodation are included.

Applications are invited for the following appointments, on or before the dates mentioned:—A lecturer in building trades at the East London Technical College, Cape Province—The Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2 (Feb. 21). A junior scientific officer under the Directorate of Scientific Research of the Air Ministry—The Chief Superintendent, Royal Aircraft Establishment, South Farnborough, Hants (Mar. 9, quoting A. 107). A director of cancer research in the University of Sydney—The Agent-General for New South Wales, Australia House, Strand, W.C.2 (May 16). A research assistant, with qualifications in physical chemistry, at the Huddersfield Technical College—H. H. Gray, Department of Chemistry, Technical College, Huddersfield. An instrument maker, preferably with electrical and optical training—The Secretary, Experimental Department, Fine Cotton Spinners' and Doublers' Association, Ltd., Rock Bank, Bollington, nr. Macclesfield.

Erratum.—Prof. H. S. Allen points out that in his letter in Nature of Feb. 12, p. 237, on "Spinning Electrons and Protons," the late Prof. McLaren's initials, correctly given by him, were printed as "G. B." Prof. McLaren's Christian names were Samuel Bruce.

Our Astronomical Column.

The Comas Sola quickly moving Asteroid.—This object was at first reported as of doubtful nature, comet or asteroid. It is now assigned to the latter class, with designation 1927 AA.

Dr. A. C. D. Crommelin has obtained the following orbit from observations extending from Jan. 10 to Jan. 24:

$$\begin{array}{rl}
T = & 1926,\ \text{Sept. } 21{\cdot}7559\ \text{U.T.} \\
\left.\begin{array}{r} \omega = \\ \Omega = \\ i = \end{array}\right. & \left.\begin{array}{rrr} 147^\circ & 25' & 14{\cdot}2'' \\ 279 & 4 & 15{\cdot}9 \\ 24 & 47 & 58{\cdot}7 \end{array}\right\} 1927{\cdot}0 \\
\phi = & \begin{array}{rrr} 16 & 8 & 18{\cdot}3 \end{array} \\
\log q = & 0{\cdot}229249 \\
\text{Period} = & 3{\cdot}5977\ \text{years.}
\end{array}$$

The orbit is of the Aethra type. The inclination is high, but much less than that of Pallas. The planet is receding from earth and sun, so its light will diminish.

A similar but somewhat brighter object is reported by Mr. Oikawa of Tokyo. It is some 20° farther north than that of Prof. Comas Sola, but has the same daily motion, $-1^{\text{m}}\ 24^{\text{s}}$, south 17′. Its magnitude is 11.

The Planet Neptune.—Mr. M. E. J. Gheury de Bray writes: "Neptune is exceptionally well placed for observation now. Any one can pick it up readily with an opera-glass magnifying two or three times. Pointing the binoculars to α Leonis (Regulus), the next star in the field in order of brightness, on the right, is ν Leonis. The next object in the field in order of brightness after ν Leonis is a little above this star and on the right. This object is Neptune. A small telescope will show other stars which may lead astray the inexperienced person. An opera-glass will only show these three objects—Regulus, ν Leonis, and Neptune, the last being the faintest of the three, so that it can be picked up in this way with the greatest ease. It is moving west and will soon approach other stars, and will then be less easy to identify, so it should be looked for now."

Sunspot Frequencies and Terrestrial Phenomena.—An interesting paper (*Journal of the College of Science*, Imperial University, Tokyo, vol. 44, Art. 6) by Prof. T. Terada has recently been received which bears the title "On Some Remarkable Relations Between the Yearly Variations of Terrestrial Phenomena and Solar Activities." The association of earthquakes with spot frequencies in the north- and south hemispheres of the sun, called *N* and *S*, is examined, and Terada finds that for some places in Japan and Jamaica, minima of earthquake frequency occur in years when $N-S$ is small, while for others, maxima occur under these conditions: some places show neither feature. Relationships with *N* and *S* are also found for the data of pressure and temperature for a network of stations over the world. The pressure associations resemble those for earthquakes; but the classification for temperature is more complex, and we have in addition one type in which maxima occur both with small and large values of $(N-S)/(N+S)$, minima occurring with intermediate values; while in another type maxima and minima have interchanged places. The paper contains much that is suggestive, and doubtless many of the results indicated are true. But there is no fixed criterion for a maximum or minimum, so that two workers may differ in their selection of these critical points; and, as Terada's statements of relationship have in most cases neither a diagram nor a numerical statement in the paper to support them, some readers will wish for the ordinary methods of correlation with their definite statement of results and their comparison with what can be expected from the working of pure chance. The idea that important geophysical phenomena depend on the difference of the sun's activities in the northern and southern hemispheres is so important that Prof. Terada's future papers will be awaited with much interest.

The Observer's Handbook for 1927 (Royal Astronomical Society of Canada).—This book contains much matter of use to observers. Besides the usual ephemerides there are maps showing the tracks of the planets among the stars. Both Jupiter and Uranus come to the north of the equator this year, after being south of it for 6 and 42 years respectively. They will be near each other in July. The period of Jupiter IX. is erroneously given as 3 years; it should be 745 days. There is a very useful table giving positions, magnitudes (apparent and absolute), spectral type, parallax, proper motion and radial velocity of a considerable number of stars.

Research Items.

ORIENTAL SEALS.—Mr. I. M. Casanowicz has issued, in vol. 60 of the *Proceedings of the U.S. National Museum*, an illustrated descriptive catalogue of a selection of the ancient oriental seals in the Museum. The collection consists of about 90 originals with flat plaster casts made from them and upwards of 200 casts of seals lent by private owners to the Museum for the purpose of making casts from them in the laboratories. The selection has been made with the view of showing a representative series of the artistic types and the mythological subjects of the seals. They come for the most part from Mesopotamia and Asia Minor and in date range from the early Babylonian to the Persian period.

PHYSICAL TYPES AND CULTURES IN AMERICA.—In Part 3, vol. 65, of the *Proceedings of the American Philosophical Society*, Dr. Aleš Hrdlička puts forward an answer to the problem, frequently propounded, of the relation of physical type to type of culture in America. The main pre-Columbian cultures are: The Moundbuilders and the Pueblos in the United States; the Toltecs, Aztecs, and Mayas in Mexico and Central America; and the Chibcha, Chimu, Nascas, Kechua, and Aymara in South America. There is no physical proof of the impact of accessions from outside which influenced any of these cultures. So far as is known, the peoples of these cultures were just Indian and nothing more. Any contact there may have been was so small as to leave no physical trace. Resemblances to other peoples, *e.g.* those accepted by Quatrefages, Ten Kate, Rivet, and Sullivan, which were held to point to Australian and Melanesian admixture, are either due to old basic relationship or individual variations which are no proof of racial admixture. The pre-Columbian Indians, however, were not all of one type. There were at least four main types: (1) Older dolichocephals—many of the tribes from South America to Mexico and California; (2) older brachycephals (Toltec type), Central America and Ecuador down the coasts of Peru to North Arica; (3) later dolichocephals—Algonkin and most Iroquois; (4) the later brachycephals—Athapascan tribes on the west coast from Alaska to North Mexico. Relating skull form to culture we find the Moundbuilders were partly Toltec, partly Algonkin; the Pueblos are mostly dolichoid, with here and there a strong dominant element of older brachycephals. The old Aztecs were a branch of the older dolichocephals, but the Aztecs of the Empire were a conglomerate: the Mayas were a pure sub-type of the older brachycephals. The Incas were also a conglomerate: the coast people were of Maya type; the mountain peoples old dolichoids. It appears that it is the older brachycephalic type which has developed the higher cultures; but the Aztecs, Aymara, most of the Pueblos, and the main element of the Kechua were of the older dolichoid type. The newer dolichoids give the Iroquois with their relatively high culture, and the newer brachycephals are responsible for some of the cultures of the north-west coast. There appears, then, no special connexion between the cultures and the physical type of the Indian.

COURTSHIP IN SPIDERS.—In three recent papers (*Ann. Mag Nat. Hist.*, 9. 18, 113; *Proc. Zoo. Soc.*, 1926, part 2, p. 318, and part 4, p. 1125) Mr. W. S. Bristowe and Mr. G. H. Locket have made some contribution to our understanding of the process of courtship in spiders. The keen-eyed wolf-spiders, Lycosidæ, have been seen waving their decorated legs and palpi before the female. It is suggested that the males are made to begin their display by the scent of the females and that the scent organs are situated at the tips of the legs and palps. Crab-spiders, Thomisidæ, are less keen-sighted and caress the female by tickling her as they walk over her. Among web-spinning spiders courtship is carried out by vibration of threads of the web on which the male plays, and induces the female to come out from her retreat. Some species of female show no reluctance and this display is much reduced. Mr. Locket deals very ably with the popular ferocity of the female, and shows that while it may be the rule for some, with others a common life may occur. The authors see a dual purpose in these pre-coition activities, *recognition* and *stimulation*. The necessity of stimulating the female has long been pointed out by others, and to this is now added the necessity that the female shall recognise the male so as to distinguish him from edible prey. *Realisation* would be a better term than recognition, for a virgin female cannot recognise that of which she has no previous experience. Realisation may be produced by the same physiological changes which, continuing, result in eagerness or a state of stimulation, the 'two purposes' of courtship being, in fact, inseparable.

ANTARCTIC ECHINOIDEA.—The sea-urchins collected by the Australasian Antarctic Expedition (1911–1914) have now been reported on by Prof. R. Koehler. There are only 21 species and a variety. and they belong to 11 genera all previously known. The new forms are distributed in the following genera: Notocidaris, 1 species, 1 variety; Goniocidaris, 1 sp.; Sterechinus, 1 sp.; Echinosoma, 1 sp.; Pourtalesia, 2 spp.; Abatus, 1 sp.; Antipneustes, 4 spp. *Goniocidaris impressa* n., from Maria Id., *Notechinus novae-zealandiae* Mortensen, from Macquarie Is., and *Echinosoma australe* n., from 35° S. 135° E., are not Antarctic. The discovery off Adélie Land of *Abatus cavernosus* (Philippi), *A. shackletoni* Koehler, and *Pseudabatus nimrodi* Koehler, considerably extends the known range of those species. Antipneustes is a name that replaces Amphipneustes Koehler 1901 to avoid confusion with the unknown Amphipneustes Wiegmann 1837; some of the species are remarkable for the size of the brood-pouches in the female. It is unfortunate that the young individuals contained in some of the pouches were not preserved well enough for study. Indeed the harvest of echinoids, especially among the more interesting but fragile heart-urchins, would have been much richer had it not been for careless packing. The report ends with a complete list of the eleutherozoic echinoderms found up till now in the antarctic and subantarctic regions.

MARINE CRUSTACEA OF THE ANTARCTIC.—The Commission dealing with the scientific results of the Belgian Antarctic Expedition has just issued a report on the Edriophthalma ("Rés. Voyage de la *Belgica* en 1897-99," Zoologie, Tanaidacés, Isopodes, et Amphipodes. Anvers, 1926). The determination of the species was entrusted to Bonnier on the return of the expedition, but the work was interrupted by his death, and not until now, more than twenty years later, has it been possible to complete the examination of the material. As M. Th. Monod, who undertook the task, justly remarks, owing to this long delay in working out the results many of the species brought back by the *Belgica* were rediscovered and described by the later expeditions to the Polar seas—by the *Southern Cross, Français, Pourquoi Pas? Discovery, Terra Nova,* and *Gauss* in the Antarctic, and by the *Ingolf* in the Arctic. But although the publication of these various reports has considerably reduced the number of the *Belgica* species new to science, it has given M. Monod a unique opportunity of collating all the evidence on the geographical distribution of these polar forms. Taking the parallel of 60° S. as approximately the limit of the antarctic and subantarctic fauna, Monod enumerates 15 species of tanaids and 133 of isopods collected by the different expeditions, including the *Challenger*. 21 out of the 27 isopod species of the *Belgica* fall into this category, 8 of them taken by the *Belgica* alone—seven being new to science, and one, *Astacilloschus Ingolfi*, recorded also from the Arctic by Hansen. The isopods form the most important part of the collection. 2 tanaid species, 1 new, and 1 new amphipod are also recorded, together with 11 other species, including the ubiquitous *Jassa falcata* and *Leucothoe spinicarpa*. The new species are defined, and the paper is well illustrated throughout with careful detailed drawings.

Milk of the Monotreme.—Milk obtained from an echidna (*E. aculeata*) has been examined by Mr. Hedley R. Marston (*Australian Jour. of Exper. Biology and Med. Science*, vol. 3, pt. 4, Dec. 1926, p. 225). The specific gravity was 1·023. The proteins consisted of a casein with albumin and globulin. Carbohydrate was present as lactose. The fat was pure triolein, and glycerides of soluble volatile fatty acids were absent. The figures obtained were (per cent.): Total solids, 36·75; casein, 8·4; albumin and globulin, 2·9; lactose, 2·81; fat, 19·62. Compared with cow's and human milk, the total protein and the fat are both very high and the fat is peculiar, but the figures are approached by those of rabbit's milk, which contains 12·0 and 13 5 per cent. of total protein and fat respectively. The author remarks that either the young echidna must store fat during the lactating period, or must be endowed with an extraordinary power of oxidation of fatty acids, otherwise extreme acidosis would follow consumption of a diet so rich in fat.

Mollusc as Agent in the Sugar-cane Root Disease.—Dr. Paul Bartsch and Mary E. Quick have been studying the small snail which, by penetrating worm-burrows and feeding on the root of the sugar-cane in Louisiana, admits infection with resulting decay of the root (*Jour. Agric. Res.*, vol. 32). The authors have successfully identified this snail with the well-known and widely distributed little *Zonitoides arboreus* (Say). This is demonstrated by means of careful comparison of its detailed anatomy with that of specimens of *Zonitoides arboreus* taken from their normal habitat under decaying bark, where their food consists largely of mycelial threads of fungi. The little animals appear to be largely nocturnal in their habits. Excellent figures of the animal, its shell, and its anatomy are given.

Constitution of the Earth.—The latest issue (vol. 1, No. 8) of the *Geophysical Supplement* to the *Monthly Notices of the Royal Astronomical Society* is devoted entirely to seismology and geodynamics. One paper, by L. F. Richardson, is concerned with the design of vertical seismographs. H. H. Turner deals with the seismological observations of *P* and *S* for the five years 1918–1922, during which the times for *P* and *S* have been compared in the *International Seismological Summary* with the adopted tables of times; the comparisons are summarised and discussed for epicentral distances less than 120°. The paper raises several new questions which must be left for later investigation. The other two papers are by H. Jeffreys; in one he rediscusses the seismic disturbances which have been best observed at short distances, and concludes that the outer layers of the earth's crust consist of about 12 km. of granitic material above a basaltic layer about 25 km. thick. No further great change of material appears to occur down to a depth of about 1000 km. The velocities of compressional waves in the two outer layers are estimated at 5·6 km. and 6·2 km./sec., that in the sub-basic layer being 7 8 km./sec. His other paper deals with the viscosity of the earth; the lithosphere is shown to be practically non-plastic, while even in the rest of the rocky shell the time of relaxation is as high as two years. The forces tending to produce secular displacement of the earth's crust (chief among them being the equatorial drift) are incapable of causing important distortion of the lithosphere during geological time, but might give appreciable bodily displacement of the lithosphere over the interior. A region stripped of granitic material by the separation of the moon would probably persist. The viscosity found for the lower parts of the shell would not preclude convection currents.

Magmatic Differentiation.—A paper on the Katmai magmatic province, by C. N. Fenner (which appears as a supplement to the *Journ. Geol.* for Oct.-Nov. 1926), is a most notable recent contribution on the origin of igneous rocks. A large number of analyses of Katmai rocks has been made, and the variation diagram indicates an almost linear variation of the oxides over a wide range of silica percentages. It is shown that differentiation by the separation of successive crystalline phases gives a broken and scattered diagram of very different and more complex form. Presumably, therefore, this process has not operated to any appreciable extent in the evolution of the Katmai rocks. There is, indeed, no known process which is competent to provide a linear variation, though Dr. Fenner suggests that volatilisation as a transporting agent is more likely to fulfil the requirements than gravitational sinking of crystals or squeezing out of residual fluids. In the course of the paper the origin of micropegmatite and graphic intergrowths is discussed; the field evidence for differentiation in different classical regions is surveyed; and many examples of the indubitable action of volatile fluxes are described. It is concluded that the operation of a variety of processes is indicated, and that Bowen's scheme of crystallisation differentiation cannot be accepted as having anything approaching the almost universal applicability that has been claimed for it in recent years.

The Fracture of Quartz by Heat.—We have received from Mr. Bernard W. Holman a copy of a paper read by him before the Institution of Mining and Metallurgy on Jan. 20, on "Heat-treatment as an Agent in Rock-breaking," together with further photographs illustrating the paper. An examination of Roman and other ancient fire-workings shows that the fragments of quartz are mostly in the form of a granular sand, and not of angular cracked fragments, as would be obtained if a fire were built against the face and water used for quenching. The granules are often cubical. Laboratory experiments show that disintegration at the transformation point, 575° C., gives granules and not splinters. Gentle pressure on a correctly heat-treated specimen gives thin laths of silky transparent quartz, often with finely toothed edges. Quartz from different sources gives varying results, and some specimens become fragile even when quenched from 300°. Only a few varieties will give the silky laths, which are the most friable form of quartz. A change in the dielectric constant is observed at as low a temperature as 340°, and the temperature at which disintegration begins varies over a range of 20°. It is suggested that the results may have a bearing on the nature of the allotropy of quartz.

It should be noticed, however, that disintegration in quartz may occur at low temperatures through the expansion of gases and vapours contained in the cavities, the extent of the cracking depending on the rate of heating, and this fact may account for some of Mr. Holman's results, without assuming any allotropic change other than the well-known transformation at 575°.

The Creation of Matter.—At the meeting of the Mathematics and Natural Philosophy Section of the Academy of Sciences of Vienna on Dec. 16, a communication was received from Dr. Arthur Haas on the increase of frequency of light quanta which impinge on swiftly moving particles of matter. The quantum and the particle are supposed to move in opposite directions and the quantum on impact has its direction of motion reversed. In these circumstances, when the speed of the particle is of the order of the speed of light, the frequency of the quantum may be so raised that the quantum is converted into a proton doublet with a wave-length of 0·013 tenth metres. As an example, the case of a particle moving with half the speed of light may be taken. The frequency of the quantum is then trebled by the impact. The author points out that the above leads to the possibility of a cosmical reconstruction of matter out of light quanta.

The Scholes Bomb Calorimeter.—A bomb calorimeter of the type originally introduced by Berthelot, embodying a number of new mechanical features, and suitable for the determination of the calorific power of solid and liquid fuels, has been placed on the market by Messrs. G. Cussons, Ltd., of Manchester. The bomb body, cover, and most of the details of the calorimeter are made of stainless steel and are machined from the solid billet. A small spanner is employed to screw the cover-nut home, and the body and base are screwed together by hand. The cover of the bomb forms the base on which the bomb stands, and the ignition rods (one of which acts as a support for the crucible cradle) are attached to the base. A form of self-sealing rubber ring, which is isolated from the combustion zone, and has been found to remain in perfect condition after more than 200 determinations of calorific power, prevents escape of oxygen or products of combustion. Oxygen enters the bomb through a spring-loaded non-return valve and is discharged through a screw-down valve. The device obviates the necessity for a gland and stuffing-box. Attachment of the ignition wire to the ignition rods is effected by insertion of the wire in slots, in which it is secured by movable sleeves. The chamfered edge of the sleeves acts as a wire cutter, effecting economy of the nichrome wire used in firing the charge.

Radiographic Examination of Coal.—We have received a portable stereoscope and some stereoscopic X-ray photographs of coal, coke, and quartz, taken by Messrs. Kemp and Thomson, Technical Radiological Laboratory, 20 Laverockbank Road, Edinburgh. X-ray stereoscopy is, of course, very familiar in medical radiology, and its utilisation for the present purpose is of interest in providing another illustration of the uses of X-rays in industry. In the case of coal the photographs reveal the extent and distribution of the 'free' mineral ash of relatively high density. The authors have also applied X-ray methods to the study of the 'jig-washing' of coal, whereby the extraneous stony and shaly matter is mechanically separated out from the clean coal.

The Burning of Gases in Nitrous Oxide.—The scanty chemical literature relating to the burning of gases in nitrous oxide is considerably extended by the recent communication to the Mancheste Literary and Philosophical Society by Prof. H. B Dixon and W. F. Higgins, of the results of thei investigations of the burning of hydrogen, methane ethylene, propylene, and acetylene in nitrous oxide Davy's generalisation that combustible bodies require a higher temperature to ignite in nitrous oxide than they do in oxygen is not confirmed, all the gases tested having *lower* ignition points in the forme gas than in either oxygen or in air. These ignition points correspond with temperatures below that at which the thermal decomposition of nitrous oxide is appreciable. The length of a hydrogen flame is increased about twelve-fold and its diameter about two-fold when the air in which the gas burns is replaced by nitrous oxide. The spectrum of the flame in nitrous oxide is continuous from red to violet with the 'steam' lines well marked. The red tinge in the flame at ordinary pressures is due to the formation of nitrogen peroxide. The paper contains tables of the respective ignition points of hydrogen in nitrous oxide at pressures between 150 mm. and 1000 mm. of mercury, and of ethylene and propylene in nitrous oxide and oxygen at 150 mm.–1000 mm. pressures.

The Separation of Radioactive Substances.—J. Kendall, E. R. Jette, and W. West have published details of the application of ionic migration methods to the separation of mesothorium-1 from barium, in the *Journal of the American Chemical Society* for Dec. 1926. The separation depends on the fact that the respective ions have different mobilities, and that during electrolysis the faster ion will gradually concentrate in front of the slower, an accumulation of radioactive material being shown by an increase in the activity per unit weight. By introducing other ions in suitable concentrations to keep the boundary sharp, and incorporating the greater part of the solution in agar gel, much more rapid and convenient separation is effected than by fractional crystallisation. Since mesothorium-1 is isotopic with radium, it is possible to apply exactly the same method to the separation of radium and barium, as it is known that isotopic ions have identical mobilities. The fact that the ions of mesothorium-1 and radium have greater mobilities than the barium ions shows that the increase in ionic mobility with atomic weight is continuous throughout the whole alkaline earth group.

The Value of Tank Testing.—The value of the method of ship model testing in experimental tanks initiated by William Froude at Torquay in 1868 has been proved over and over again. Such testing gives the designer a mass of useful data and settles the form of hull and propeller to give the best results. But as Pepys said long ago, "It seems worthy of note how small things are sometimes found to mar or mend a ship's quality of sailing." The importance of minor details was really the theme of Mr. G. S. Baker's paper, "The Economy of Tank Testing of Ship Forms and Research in Ship Propulsion" read on Jan. 28 to the North-East Coast Institution of Engineers and Shipbuilders. The points dealt with included the form of the shaft webs and brackets; the bossing and direction of rotation of the propellers; the shape and section of the blades. At first, tank testing was confined to the determination of the factors which make up the resistance of war-ships in still water. It was extended to the study of propellers by R. E. Froude and to merchant ships by Messrs. Denny. In the National Tank, of which Mr. Baker is director, during the years 1924–26, no less than 80 designs were tested, and in an appendix to the paper are notes on the results.

Diet and Cancer.

THERE have been and are all sorts of statements about the relation of diet to the occurrence of cancer. We are told that eating raw carrots will prevent and even cure it; others attribute efficacy to onions, others to a salt-free diet; tomatoes, on the other hand, have been suspected of causing cancer. Particularly common is the suggestion, which appears at times to have crystallised into a belief, that vegetarians suffer from malignant disease less than ordinary people who take a fleshy diet.

None of these statements has been subjected to critical inquiry; and indeed such inquiry is by no means easy, for it is hard to find two bodies of persons, in other respects wholly comparable, who differ only in their enjoyment or rejection of meat. The vegetarians in Great Britain, for example, could not, without the strictest inquiry, be regarded as a sample of the population which differed from the normal only in their avoidance of meat; there are many grades and subclasses of vegetarians, but, taken as a whole, they form a group distinguished in many modes of life and thought besides their diet. In the world at large, vegetarianism, in short, is generally a character associated with other exceptional features of body and mind, and any advantage or disadvantage which vegetarians may show in the incidence of disease may be due to their general make-up as likely as to the nominal outward sign of it. The study of such associations in man is, indeed, difficult, and is liable to be extremely fallacious.

Particularly welcome, therefore, is the report on the incidence of cancer in certain religious orders by Dr. S. Monckton Copeman and Dr. Major Greenwood.[1] With the co-operation of the ecclesiastical authorities and with an amount of detailed inquiry which must have been even more troublesome than it seems, they have collected the necessary statistics in a number of religious houses in England and elsewhere. The monks, nuns, and lay brothers in these communities are all essentially vegetarians: but we can be pretty sure that vegetarianism is no more than an incidental circumstance, and that the nature of the diet has had no influence in determining the membership of these communities. Among the Carthusians and Cistercians the rules are especially strict, and a life which is spent in silence in a cell from which the monk comes out only for a nightly service, for a meal in the refectory on Sundays, and for a weekly walk, cannot be said to involve much of that hurry, luxury, and excess to which cancer and other sickness is so often ascribed. But the results of this minute inquiry into their mortality shows that, while perhaps as a whole the mortality is in some instances rather less than would be expected in persons of similar age and sex in the outside world, there is no evidence at all of any immunity to cancer. Thus in a Cistercian house in England, 427 people lived between 1800 and 1920: there were 104 deaths against an expectation of 82 in the general population, and of these 5 certainly, and 3 probably, died of cancer, as compared with 5 or 6 in non-monks. Cistercian nuns in England and a Belgian house of the same order give similar results, as do Benedictine and Carmelite communities in which the rules are not quite so strict. Taken separately or together, the figures lend no support to a proposition that cancer is either less or more common inside monasteries than among the contemporary comparable part of the population outside.

Finally, data are given which were collected less minutely and completely from 57 Cistercian houses in different parts of the world: the figures seem to show a singularly small number of deaths from cancer, but, as the authors point out, the calculations are subject in these instances to so many qualifications that one is once again reduced to the conclusion that there is no evidence of any difference either way. Any one who feels inclined to rush in and solve the problem of the causation of cancer by statistical methods should study carefully this admirable example of how such work should be done: it is much more difficult than some enthusiasts imagine.

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[1] Ministry of Health. Reports on Public Health and Medical Subjects, No. 36: Diet and Cancer, with Special Reference to the Incidence of Cancer upon Members of certain Religious Orders. By Dr. S. Monckton Copeman and Major Greenwood. Pp. iv+33. (London: H.M. Stationery Office, 1926.) 9d. net.

Maori Navigation.

THE vessels used by the peoples of the Pacific in their migrations and colonisations are of primary importance in Oceanic ethnology. They have been described by various writers, but only partially, and generally from the technological side. Now, in an interesting *Bulletin of the Dominion Museum of New Zealand*,[1] Mr. Eldon Best has collected all that is known or can be learned from native sources about Maori canoes. Every aspect of the subject is discussed and fully illustrated by copies of early prints or modern photographs.

Some types of Maori canoes have entirely disappeared. The double canoe, formed by two dug-outs united by a platform, survived until about 1830. The occurrence of the single canoe with one outrigger is denied by some writers, although it is said to have been seen by Captain Cook. The single canoe with double outrigger is said to be only mentioned in tradition. This becomes important when it is noted that Indo-Javan vessels twelve centuries ago had double outriggers.

The only native canoe now used is that without an outrigger. The generic name is *waka*. Varieties are distinguished as the *waka taua*, war canoe, *waka tete* used for fishing and travelling, and the *waka tiwai* and other small craft used in calm waters.

The building of the *waka taua* is fully described. The tree, of *totara*, *kauri*, or other timber, was reserved by clearing the bush around or by a taboo. A strip of bark might be peeled off one side to initiate decay and facilitate hollowing out. On an auspicious day, after fasting and ritual, the trunk was felled. Sometimes the lower part was scarfed, or the uncovered roots were burned, or an ingenious machine on the ballista principle was used. The trunk was charmed to prevent damage in falling. The hollowing was performed by burning and by the stone adze. Canoe makers wore only one garment, and their food, reserved for them alone, was cooked apart. It was etiquette for a visitor to throw his spear at the canoe. If it stuck, the omen was favourable. The hull was hauled to the water side by ropes, often for long distances, by many people. Charmed skids eased the canoe over rough ground. Sometimes the hull was composed of more than one piece.

The sides of the dug-out were heightened by an ornamental top strake, butted and lashed to its top edge by strings of flax, and caulked with fibre. The join was covered by a batten. The ends of the top strake were drawn in by a tourniquet and the lashings tightened with a lever. The ends of the dug-out were fitted with figure-head and stern piece, coloured red and black and ornamented with feathers. The deck was a mere grating. The launch was carried out according to ritual and was followed by a ceremonial feast.

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[1] New Zealand, Dominion Museum. Bulletin No. 7: The Maori Canoe. By Eldon Best. Published under the direction of the Board of Maori Ethnological Research, for the Dominion Museum. (Wellington, N.Z.: W. A. G. Skinner, 1925.)

Mr. Best describes in less detail the fishing and river canoes, and also the canoes of the Chatham Islands. An account is also given of ceremonial observances in the use of canoes.

The common mode of propulsion was the paddle, but poling was often resorted to when ascending streams or in shallow water. Steering was effected by a long paddle at the stern or by directions to the paddlers. Mr. Best gives specimens of the songs sung while paddling. The sails formerly used were triangular, with the small end downward. They were made of matting or laced leaves. Generally only one sail was used, but large canoes might have two or three. Stones were used as anchors. They were used in the natural state or with grooves pecked round the middle to fit the rope, or in baskets. Baling was performed with carved balers having the handles projecting forward.

Mr. Best gives a summary account of canoes of the Pacific area, quoting from various authors. Gilbert and Loyalty Island canoes are included with the Polynesian, and only short notes are given on those of Melanesia, Micronesia, and Indonesia. At the end of this chapter Maori methods of navigation are described, and the Maori and Moriori compass points enumerated, without reference to other island names.

An interesting chapter is devoted to Maori traditions of the discovery and settlement of New Zealan by visitors from eastern Polynesia, from an islan Hawaiki, which Mr. Best identifies with Tahiti. Th first voyagers were Kupe and Ngahue. They circumnavigated New Zealand and named it Aotea-roa They found no human inhabitants but reported o their return to Hawaiki that the most valuable products of Aotea-roa were the *moa* and *pounam* (nephrite). Toi, a later visitor, found the island inhabited by the Maruiwi or Mouriuri, a dark-skinne people with bushy hair. The voyage of Toi and tha of his grandson Whatonga led to the colonisation o New Zealand, and voyages thereto became frequent Mr. Best gives an account of Maori voyages and th historic canoes in which they were made.

With its list of Maori navigation terms, bibliography, and index, the work forms a valuable compendium and record of one group of Polynesian cano builders and navigators, and Mr. Best has done rea service to Oceanic ethnology by its compilation.

In some places the linguistic comparisons are weak Tonga *hama*, Rotuma *sama*, Fiji *thama* are assume to be derivatives of the Maori *ama* (outrigger). Th Tonga *fohe* and Samoa *foe* are said to come from th Maori word *hoe* (paddle). The Fijian *wanka* (cano and shrine) is said to be a Maori term. But the name as found in Tonga, Rotuma, and Fiji are older than i Maori. The original words were *semang* or *soma* (outrigger), as in the Moluccas and Batjan; *boseh* *borsi*, or *bogsai* (paddle), as in Java, Sumatra, and th Philippines; and *banka* or *wanga* (canoe), as in th Philippines and Celebes.

Sidney H. Ray.

Planets and Periodicities.

THE nineteenth century discarded horoscopy of the weather with the other appurtenances of astrology. Dr. Z. Kamerling[1] would have us reverse the verdict and employ the motions of the planets as the basis of long-range forecasting. His thesis is that widespread periodicities must have a cosmic origin, and sunspots having failed, there remain only the planets. Accordingly he investigates periodicities of the length of the 'synodic rotations,' that is, the intervals between the dates at which the various planets are nearest to the earth. (It appears that the theoretical basis of this planetary connexion has been given in a previous paper; one wonders what it can possibly be.) These give him in years: Venus 1·60, Mars 2·13, Jupiter 1·09, Saturn 1·035, Uranus 1·018. As material he has forty years of average monthly rainfall over east Java and over west Java, twenty years' rainfall at Pernambuco, and temperatures at Winnipeg, Konigsberg, and Zwanenburg. The method is to write down the monthly data in sets corresponding with the 'synodic year,' so that, for example, all the months of perigee come in the same vertical column, and to plot the smoothed means of these columns. From his graphs Dr. Kamerling concludes that there are real periodicities corresponding with the synodic periods of each planet, giving maxima generally near perigee and secondary maxima near apogee.

Such a result would be of considerable importance if substantiated, as explaining the origin of a number of periodicities of a little more than a year which have been suggested from time to time, but unfortunately the author has not done all he might to prove his case. He does not express his periodicities as Fourier series, nor does he attempt to determine their exact length. The original data are given only for the east Java rainfall, and here inspection shows that the annual variation has not been completely eliminated. They show, in fact, a residual mean annual variation with a range of 16 mm., which is of the same order as the ranges of the planetary periods. The normal used apparently covers the first thirty-three years, so that the error is entirely concentrated in the last seven years, and falsifies any apparent periods up to 1·1 year. The supposed period for Uranus (1 year 4 days), with a range of 18 mm., is almost entirely due to this residual annual variation. The author does not give the standard deviations of the data which he uses, so that no test of reality can be made. The Venus period in east Java, which has by far the largest range of any, may be taken as a test case. The amplitude of the corresponding Fourier series is found to be 9 mm., and the standard deviation of the original 480 values is 63 mm. The amplitude is therefore 4·5 times the expectancy on a chance basis, and the period seems to be real. Its exact length, however, turns out to be 1·58 year, while the 'synodic year' of Venus is 1·60 year; this means that the maximum phase shifts by about 120° in forty calendar years, which seems too great, and the interpretation suggested is that there is a periodicity in the east Java rainfall which happens nearly, but not quite, to coincide with the Venus synodic year.

The curve for Mars shows very little trace of the whole period, but a well-marked half-period of 1·06 year, which may be due to the residual annual variation in the data. The present writer is not impressed by the supposed approximation of the maxima to perigee and apogee, since to him the graphs rather suggest a haphazard distribution of phase. Hence it seems necessary for the author to repeat his work, using more refined methods of analysis, and where possible longer series of data. The title of the paper is a misnomer, since the results would be of little use for forecasting purposes.

C. E. P. B.

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[1] "Grondslagen voor een Weervoorspelling op langen Termijn." Door Dr. Z. Kamerling. 1: Enkelvoudige Perioden van Wijziging der Weersgesteldheid. Pp. 30. (Leiden: A. W. Sijthoff, n.d.) n.p.

The Indian Lac Research Institute.

THE importance of lac in the markets of the world is well known to many; also the fact that at the present time India enjoys practically a world-wide monopoly of the lac industry. Owing to serious fluctuations in the price and output from time to time, speculation is rife and steps are being taken with the object of endeavouring to stabilise the trade. A Government inquiry was carried out by Messrs. H. A. F. Lindsay and C. M. Harlow, their report being published in 1921. An outcome of the report was the formation in the same year of the Indian Lac Association for Research. It was decided to build and equip a Lac Research Institute and to run in conjunction with it a small experimental plantation. The Association is managed by a committee of Europeans and Indians representing all branches of the trade. Funds are obtainable by a small cess imposed by the Government of India on all exports of lac, manufactured and unmanufactured. A report of the work of the four years (to Mar. 31, 1926) has been issued (Calcutta: Thacker, Spink and Co.).

The greater bulk of the lac produced comes from Central India, *i.e.* the Central Provinces and Chota Nagpur. This factor determined the selection of the site for the research institute. Ninety per cent. of the lac produced comes from a fairly compact area comprising Chota Nagpur, the Feudatory States of Orissa, a few adjoining districts of the Central Provinces, and a few adjacent areas in Bengal and the United Provinces. From this area Bihar and Orissa claim more than half the annual production of lac in India. Thus Ranchi, one of the capitals of this Province, was selected as the home of the future Institute. The local government provided a site of 110 acres a few miles out of the town on favourable terms, and construction work was commenced in 1924, the foundation-stone being laid by the Governor of the Province. The Institute building includes laboratories for biochemistry and entomology and was finished in August 1925. The research staff consists of (1) the director and biochemist appointed in Oct. 1923, (2) three assistants to the biochemist appointed in June 1925, (3) an entomologist and three assistants, all appointed in 1926. The biochemist, who is also director, is Mrs. Dorothy Norris, and she has been in charge since 1923.

Lac production in the past has been either undertaken by the officers of the Indian Forest Department or by local proprietors and others, the material being sold to middlemen for transmission to the big markets. A certain amount of research work has been carried out in recent years by officers of the Department in connexion with improvements in collection and outturn, studying insect pests of the lac, and so forth.

The main objects of the Lac Association may be taken to be the establishment of the lac industry on such a sound commercial basis that competition need not be feared, owing to "(1) A synthetic product such as affected indigo and would have affected rubber but for the drop in price of the natural product. (2) The establishment in other countries of the lac insect itself as has been done in the case of silk."

The Forest Department in the Province is co-operating with the Institute by affording facilities for experimental work in selected areas of forest, thus supplementing the experiments which are being carried out with species, spacing, and so forth on the Institute's own land. The work of the Institute is being welcomed in the Province. As an example of a purely private and commercial undertaking, even though assisted by Government, its inauguration in India is a striking illustration of modern progress.

Women in Factories.

ON Jan. 28, Prof. Edward P. Cathcart lectured at the Royal Institution of Great Britain on "The Physique of Women Employed in Industry." He began his lecture by deploring the fact that while a large amount of work has been done on the anthropometry of man, little attention had been given to the determination of the physical measurements of women. He points out that a real necessity for such knowledge exists quite apart from the theoretical scientific value of the facts, for if, as is likely, legislative action is to be taken with regard to protection from overloading, then definite knowledge will be required.

The problem was studied along the following lines:

(1) The determination of the physical characters of the average woman engaged in industry.

(2) The determination in the laboratory of the optional load.

(3) The determination of loads actually carried in the course of ordinary work by women.

Details of the first section of the research were presented in the lecture. Some 3000 factory women were studied, and as controls a group of unemployed women and a group of women students. Records were obtained of the age, weight, height, lumbar pull, grip, and crush. The factories represented a variety of trades. The heaviest work done was in the chemical and brick trades, and Prof. Cathcart paid a tribute to the physical strength and grace of the women, although they were drawn from one of the worst districts of Glasgow.

A good correlation was found to exist between the various strength tests, indicating that there is, if the strength depends mainly on muscle development, a more or less uniform development of muscle in the different subjects, or, if the strength tests are indicative of more than muscle development, then the factor operative is uniform for all types of muscle activity.

A comparison of the unemployed and the employed showed that the unemployed were of poorer physique than the employed. This did not appear to be due to lack of nutrition or flabbiness of muscle through lack of use. The college women tested exceeded in height, weight, and strength the other two groups, and from the statistical evidence given, this did not appear to be due to bad sampling. Prof. Cathcart thinks the difference is probably due to the fact that the college women had already been selected by medical examination, that they received good physical training, and also that strength is not merely a function of the amount of muscle present but is also related to mental alertness that enables a subject to co-ordinate his powers more successfully when called upon to produce some extra effort. From a practical point of view, he thinks it would be well if women below a certain fitness factor were not employed in hard factory work; also that those employers who encourage physical training are doing work that is valuable both from the point of view of the worker and of the work.

We would also add that if Prof. Cathcart's findings as to a fitness factor can be substantiated, the knowledge will be of very great value to those engaged on vocational guidance. Careful studies such as this are of very great value and are applicable to a wide range of problems.

University and Educational Intelligence.

Cambridge.—The Council of the School of the Biological Sciences has been constituted as follows: Dr. Adrian, Prof. Barcroft, Mr. Bartlett, Mr. Blackman, Prof. Buxton, Mr. Forster Cooper, Prof. Dean, Sir F. G. Hopkins, Mr. Nicholas, Dr. Rideal, Prof. Seward, and Prof. J. T. Wilson.

The Faculty Board of Medicine has reported in favour of continuing the diplomas in public health, hygiene and tropical medicine, and hygiene until 1930, but for no longer unless the University otherwise determines at a later date. The foundation in 1922 of the London School of Hygiene and Tropical Medicine has altered the situation at Cambridge. When the new school is completed it should offer facilities for teaching and research with which Cambridge would be unable to compete. The Cambridge diploma in public health established in 1875 may be succeeded in due course by analogous diplomas at the new school.

The provision of facilities for special study and teaching in neurology and mental hygiene at the Maudsley Hospital, and the fact that only part of the course of study for the diploma in psychological medicine could be well provided at Cambridge, has led the Faculty Board to recommend that this diploma be discontinued as from October next. The Faculty Board recommends that the diploma in medical radiology and electrology should be continued for a further period of three years, with a fresh provision that before admission to the second part of the examination the candidate should have had a proper clinical experience of the subject.

Reading.—Mr. Alfred Palmer, president of the council of the University, has been given the degree of Doctor of Science *honoris causa*. This is the first degree which has been awarded by the University.

From University College, London, we have received "These Hundred Years," the oration delivered by Sir Gregory Foster on the occasion of the thirtieth celebration by the College Union Society of the foundation of the College. The title of the address is a reminder that the College centenary is to be celebrated this year. The great transformation—religious, political, social, and educational—that has taken place in these hundred years is, as Sir Gregory Foster says, due largely to the progress of science. He quotes Sir John Herschel's scathing criticism of the state of the exact sciences at the beginning of the nineteenth century: "Mathematics was at its last gasp, astronomy was nearly so. . . . The chilling torpor of routine had spread itself over all those branches of science which wanted the excitement of experimental research." There was no place in England where chemistry was systematically taught, and there was no chemical laboratory until one was opened at University College in 1828. The important part played by the College in the astounding progress witnessed by the hundred years that followed is briefly touched on in the address and will doubtless be celebrated at length in due course. In accounts of the origin of the College (and of the University of London) its debt to the poet Thomas Campbell is commonly acknowledged, but it is not so commonly recognised that the great principle of freedom from religious rivalry which the poet so eagerly and successfully championed was by him imbibed from the University of Berlin, founded, under the guidance of Wilhelm von Humboldt, in 1809, "unattached to any particular creed or school of thought, and devoted only to the interests of science and learning."

Calendar of Discovery and Invention.

February 20, 1880.—In one of the notebooks of David Edward Hughes preserved at the British Museum is an entry dated Feb. 20, 1880: "Mr. Spottiswoode, President of the Royal Society, Prof. Stokes, and Prof. Huxley visited me to-day at half-past 3 P.M. and remained until 6 P.M. in order to witness my experiments with the extra current Thermopile, etc." Hughes was then making experiments in the transmission of signals across space by means of the radiation given off by what he called the 'extra current' from a small spark coil, using for reception a Bell telephone and battery connected to a separate receiving circuit including sometimes a microphone. Neither Hughes, however, nor his visitors had any conception that the effects obtained were due to electro-magnetic waves.

February 21, 1824.—While professor of chemistry at Jena, Johann Wolfgang Döbereiner in 1823 discovered that when platinum in a fine state of division, known as platinum black, is placed in oxygen, it absorbs many hundred times its own volume with a considerable rise in temperature. Spongy platinum he found acted in the same way, and on Feb. 21, 1824, he patented his lamp, in which a stream of hydrogen is ignited by being directed on to such platinum.

February 22, 1804.—Trevithick, the famous Cornish engineer, was a pioneer in the use of high-pressure steam and was the father of the locomotive. His first practical experiments with a railway locomotive were made at Merthyr Tydvill in 1803–4, and on Feb. 22, 1804, his engine conveyed 10 tons of ore, 70 men, and five wagons a distance of 9¾ miles at about 5 miles an hour.

February 22, 1831.—The virtual founder of the British Association was Sir David Brewster. Johnston the chemist, in 1830, had written an account of the German Association of men of science. On Feb. 22, 1831, Brewster wrote to Prof. Phillips at York: "It is proposed to establish a British Association of men of science similar to that which has existed for eight years in Germany, and which is now patronised by the most powerful sovereigns of that part of Europe. The arrangements for the first meeting are in progress; and it is contemplated that it shall be held in York, as the most central city for the three kingdoms." Murchison, Robison, J. D. Forbes, and Vernon Harcourt were among its chief promoters.

February 24, 1891.—The process for producing seamless steel tubes such as are used in modern boilers is due to Reinhard and Max Mannesmann, one of whose patents is dated Feb. 24, 1891. A heated round billet is spun at a high velocity by rollers which, being slightly inclined to one another, also give the billet an endwise motion. A flow of metal takes place from the interior outwards, a tube being formed the interior of which is smoothed by its being forced over a mandril.

February 24, 1896.—No discovery created more stir in scientific circles than that of the Rontgen rays, but no sooner had it been made known than a new field of investigation was opened up by Henri Becquerel, who, seeking to test whether such rays always accompanied the excitation of phosphorescent light, was led to the discovery of radioactivity. His experiments were made known to the Paris Academy of Sciences in his memoir, "Radiations émises par phosphorescence," read on Feb. 24, 1896.

February 26, 1788.—The Linnean Society was founded through the efforts of Sir James Edward Smith, the inaugural meeting being held on Feb. 26, 1788, at the Marlborough Coffee House. E. C. S.

Societies and Academies.

LONDON.

Royal Society, Feb. 10.—**C. D. Ellis** and **W. A. Wooster**: The photographic action of β-rays. The β-ray spectra of radio-active bodies were recorded as usual on a photographic plate, but homogeneous beams separated by magnetic deflexion were used. The reciprocity law is found to hold, and the form of the blackening curve is independent of the time of development and of the velocity of the particles between $H\rho$ 1450 and $H\rho$ 5830. The blackening curve follows a simple empirical formula which is identical with that holding for the blackening by X-rays, the constants in the formula showing the same variation with velocity as holds for variation in frequency in the case of X-rays.

C. D. Ellis and **W. A. Wooster**: The relative intensities of the groups in the magnetic β-ray spectra of radium B and radium C. With the method used, the intensities of the groups in the two spectra are measured on the same scale and refer to equal numbers of disintegrating atoms. An interesting result is that the ratio of the intensities of the groups due to conversion of the same frequency γ-ray in the K and L levels is independent of the frequency and equal to that occurring in the ordinary external absorption of X-rays. Using Gurney's determination of the number of electrons in the strong groups of radium-B, the number of electrons in all the other groups are deduced. Hence the total number of secondary electrons emitted from these two bodies can be determined.

A. Muller: An X-ray investigation of certain long-chain compounds. The substances were in the form of well-developed single crystals. They contain straight carbon chains of identical or very nearly identical zigzag structure. The angle between two lines connecting the centres of three consecutive carbon atoms is little different from the tetrahedral angle (109° 30′). The chains can be represented by rods of elliptical cross-section. In the crystals these rods are packed in bundles or, in other words, with their axes parallel to a fixed direction in the crystal lattice. The density of packing of these rods is the same for all the substances. Comparisons between X-ray data and others obtained by Langmuir and Adam from measurements of mono-molecular films of long-chain compounds, suggest that the crystal structure and the structure of the compound film are very similar, if not identical.

G. H. Briggs: The straggling of α-particles from radium C. The variation in velocity is measured by the magnetic deflexion method when the rays passed through various thicknesses of mica. The deflected and undeflected bands produced on a photographic plate are analysed by a microphotometer. The distribution of energies on emergence is very approximately Gaussian in form. From the energy distribution, the straggling of the ranges can be calculated at any point in the region investigated; it is about 1·4 times that predicted by Bohr. Half the total straggling in range occurs in the first 2·4 cm. of the path. The discrepancy between theory and experiment would be explained if transfers of energy occur twice as often as theory indicates.

G. H. Briggs: The decrease in velocity of α-particles from radium C. For velocities less than 0·55 V_0, the velocity decreased much more rapidly than was found by Marsden and Taylor, but is in agreement with the results near the end of the range found by indirect methods by Kapitza and by Curie. The ratio of the number of singly to doubly charged α-particles varied as $V^{-4\cdot3}$. Experiments to detect any lack of homogeneity in the initial velocities of the α-particles gave no evidence of velocities greater than the average by more than 1 in 3000. Velocities less than the maximum were present, due probably to absorption in the source.

L. H. Thomas: On the capture of electrons by swiftly moving electrified particles. The chance that a fast α-particle will capture an electron is calculated in two cases; for particles with velocity greater than 8×10^8 cm./sec. moving through hydrogen or helium, and for particles with velocity between 4×10^8 and 2×10^9 cm./sec. moving through heavy matter. The method is to split up the process into a close collision of the particle with an electron and a close collision of this electron with an atomic nucleus. The results are in agreement with those obtained experimentally.

Linnean Society, Jan. 20.—**H. Graham Cannon** and **Miss S. M. Manton**: Notes on the segmental excretory organs of Crustacea. The patterns of the maxillary gland efferent ducts of the Branchiopoda show a marked uniformity. The simplest type is that of Estheria. In Chirocephalus there is a divergence from this pattern, probably correlated with the absence of a shell-fold. In the maxillary gland of Anaspides the pattern of the duct is the same as that of Chirocephalus. The maxillary gland of each possesses a muscular sphincter controlling the exit of the efferent duct from the end sac. The entire gland is mesodermal. The Lophogastridæ represent primitive Peracarida, from which both the modern mysids and isopods could have evolved. The segmental excretory organs of the former are antennal glands and of the latter maxillary glands. Lophogaster possesses both antennal and maxillary glands.—**R. R. Gates**: The tundra vegetation of Russian Lapland. The plant-breeding station at Khibiny, in Russian Lapland, north of the Arctic Circle, in lat. 67° 44′ N., is on Lake Ymandra, and is partly surrounded by mountains which reach a height of nearly 4000 feet. The summer season begins about the middle of June, when the ice goes out of the lake, and ends about the end of August. During this short season most of the plants bloom twice, June and August. The snowfall is not heavy and the rainfall about 450 mm. In February the lowest temperature is about −36°·4 F., while in June—the warmest month—the mid-temperature is 53°·6 F. and the maximum 86° F. There is very little rain from May to August, but the winds are always very strong and have a marked effect on the vegetation. There are many kinds of tundra. The mountain rock tundra above the tree-line at Khibiny is very similar to the low rock tundra on the Arctic coast. Moor tundra is typical of Siberia, and but little of it is found in the Kola Peninsula. Cladonias and other lichens make up a conspicuous element and give a whitish character to the landscape. This may be free from trees (*chuna* tundra) or may be interspersed with pine. In the Ural Mountains is *Flecken* tundra, characterised by its patchy covering of vegetation with areas of bare yellow clay. In *Klotschkovataya*, or tufted tundra, in the Kola Peninsula, the surface of the ground is broken into polygonal areas, which may be thirty feet across and are covered with vegetation. Between these *Klotschy* are crevices which may be ten feet deep and six feet wide, with vegetation at the base. All these forms of tundra have many features in common, Cladonias and other lichens as well as heaths and woody creepers being conspicuous elements in the plant-covering. Tundra vegetation appears to be chiefly the result of a soil which is wet and frozen during much of the year, general low temperature, and continuous high winds. The continuous daylight during the greater part of the summer season favours quick maturity in the flowering plants. Occasional summer fogs occur, but farther north on the Murmansk coast they are much more frequent and very dense.

Geological Society, Feb. 2.—**V. C. Illing**: The geology of the Naparima region of Trinidad (British West Indies). The area around San Fernando is covered almost entirely by a series of sands, clays, and marls of Lower and Middle Tertiary age, the marls being responsible for the black soils which have become the home of the sugar-cane industry. These Tertiary deposits have been formed in two separate basins, separated by an important zone of uplift extending from San Fernando in an east-north-easterly direction. The Upper Argiline, generally considered to be Cretaceous, is placed in the Upper Eocene on the evidence of the foraminifera, and is followed unconformably by a series of sands and silts, also of Upper Eocene age. The Oligocene is only partly represented, but the late Oligocene and early Miocene Periods show a thick series of clays, marls, and sands. The marl facies is almost completely restricted to the southern basin, and is merely a facies of the more widespread foraminiferal clays. The rocks of the area are moulded by a series of thrusting movements coming generally from the northward, the main trend of the folding being east-north-easterly. Associated with the movements which have clearly recurred at distinct periods in Tertiary times, there has been emergence of the central land-ridge and the formation of shallow-water beach-deposits at the maximum periods if uplift.—**W. L. F. Nuttall**: Tertiary Foraminifera from the Naparima district of Trinidad (British West Indies). The rocks of the Naparima district consist of an upper and a lower series, which rest upon one another unconformably. Foraminifera are abundant in these beds, and indicate that the upper series is of Miocene-Oligocene age and the lower series Upper Eocene. There are two distinct areas separated by a zone of over-thrust faulting. The stratigraphical sequence and foraminiferal faunas of these areas are dissimilar, and the explanation offered is that they were originally two separated basins of deposition.

Edinburgh.

Royal Society, Jan. 24.—**Henry Briggs**: Rock-faulting from the engineering standpoint. The bearing of Mohr's theory of rupture on the angle of fracture of rocks of different degrees of brittleness is discussed, and the character of the three-dimensional stress-systems required to produce normal, transcurrent, and reversed faulting is ascertained. This carries the quantitative methods of the engineer into a branch of geology.—**W. J. M'Callion**: The geology of Gigha. Gigha is a small island off the western coast of Kintyre and about 5½ miles south-east of West Loch Tarbert. It is 6 miles in length from north-east to south-west, and has a greatest breadth of 2 miles. The rocks of the island are composed of quartzites, phyllites, and epidiorites belonging to the Erins Quartzite division of the Ardrishaig group which is so well developed in South Knapdale. Kainozoic crinanites and olivine dolerites are very abundant.—**A. R. Normand, J. B. M. Ross**, and **E. Henderson**: The distribution of intensity in the X-ray spectra of the normal saturated dicarboxylic acids, their diethyl and mono-ethyl esters. The intensity distribution among the several orders of reflection from the principal spacing planes was calculated by Shearer's method. The calculated and observed results on comparison showed good agreement, thus confirming the structures assigned by the authors to this series of compounds.

Paris.

Academy of Sciences, Jan. 10.—The president announced the death of Antoine Balland, corresponding member for the Section of Rural Economy, and of Haton de la Goupillière, free member.—**Emile Borel**: Systems of linear forms with a left symmetrical determinant and the general theory of play.—**Emile Borel**: A problem of geometrical probabilities relating to the circle.—**G. Ferrié** and **R. Jouaust**: A free pendulum maintained by a photo-electric current and its application to the problem of time. The free pendulum, the mechanism of which has been described in an earlier paper, has been observed for more than twelve consecutive hours, and the interval of time between two successive records of beats has been constant to 0·001 sec., an order of accuracy higher than that hitherto attainable.—**L. Gustave Du Pasquier**: Groups of Hamiltonian quaternions.—**Mme. M. Piazzolla-Beloch**: Hyperelliptic surfaces of rank 2.—**Tibor Radó**: The area of curved surfaces.—**Norbert Wiener**: A generalisation of functions with limited variation.—**André Weil**: Functional spaces.—**Stefan Kempisty**: Integration of the regular differential.—**Arnaldo Masotti**: The composition of the movements of a perfect liquid parallel to a fixed plane.—**R. Mazet**: Flow through a circular orifice.—**F. da Costa Lobo**: Two interesting prominences. A description of observations made with the spectroheliograph at the astronomical observatory of the University of Coimbra on Aug. 5 and Oct. 7.—**Th. Vautier**: Velocity of waves [of explosions].—**Paul Gabriel Girault**: A mechanical image of hysteresis and the inconstancy of the Steinmetz exponent.—**Louis de Broglie**: The possibility of bringing into agreement the electromagnetic theory with the new undulatory mechanics.—**Léon Brillouin**: Is it possible to detect directly the magnetic moment of the electron? An experiment is conceived which might decide this question. The necessary conditions are difficult to realise, but do not appear to be impossible.—**Albert Pérard**: Quartz standards, checks of the metric unit. Results of the length measurements and of the indices.—**S. Piña de Rubies**: The arc spectrum of europium. Measurements made at the normal pressure between 3100 Å.U. and 2200 Å.U. A list of the wave-lengths and intensities of the lines is given, also a list of lines given by Exner-Haschek and by Eder, attributed to europium but considered by the author to be due to impurities.—**C. Mihul**: New researches on the structure of the spectrum of oxygen.—**Andrieux**: A method of high-temperature electrolysis of oxygen compounds. Application to the preparation of a certain number of metals and of borides. The electrolytic bath consists of a mixture of metallic oxide, boric acid or borax, and fluoride of an alkali or alkaline earth. Electrolysis with a high current density gives the metal (fused or crystalline); with low current density, borides are obtained.—**W. Swietoslawski** and **S. Poznanski**: The equilibrium constant of the esterification reaction in the gas phase.—**Edmond Vellinger**: The rotatory power of organic substances as a function of the pH; malic acid. The curve of rotation of malic acid as a function of the pH generally resembles that given by tartaric acid and can be calculated by the same formula.—**Jean Thibaud**: The polymorphism of the fatty acids.—**Picon**: The action of high temperatures on some metallic sulphides. Iron sulphide heated in a carbon tube *in vacuo* commences to dissociate into its elements at 1100° C., while manganese sulphide volatilises without decomposition at 1375° C. Chromium sulphide decomposes at about 1350° C.—**Charles Dufraisse** and **Henri Moureu**: A method of preparation of the α-diketones, starting with ketones of the type $R.CO.CH=CH.R'$.—**Mme. Ramart-Lucas** and **F.**

Salmon-Legagneur: The action of phenylmagnesium bromide on the trisubstituted acetonitriles. This reaction yields trisubstituted acetophenones. With the exception of trimethylacetophenone, all the ketones described are new.—**Edgar Aubert de La Rue**: Some minerals from the Ivory Coast.—**Léon Bertrand**: The rôle of the Alpine Triassic spur of central Vésubie in the recent landslides of Rocquebillière, Belvédère and Lantosque.—**W. Kopaczewski** and **A. de Moraes Sarmento**: The extreme lability of certain mineral waters.—**O. Munerati**: Three generations of *Beta vulgaris* in the space of one year.—**Abelous** and **Argaud**: The different vicariant modalities in animals without the spleen. A discussion of the modes in which glands may be modified to perform some of the functions of the spleen when the latter has been experimentally removed.—**J. Nageotte**: Coagulation *in vitro* of collagen dissolved in a dilute acid.—**A. Policard**: The phenomena of reparation of fractures studied by the method of tissue culture.—**C. Hosselet**: The genesis of the myofibrils and the radiate structure in the myoblasts of the legs of *Culex annulatus*.—**René Lambert** and **Georges Teissier**: The theory of biological similitude.—**L. Mercier** and **Raymond Poisson**: Remarks on a case of macrophthalmia in an eel.—**A. Astruc** and **M. Mousseron**: The various soluble ferments contained in black mustard (*Brassica nigra*). Mustard seed is rich in ferments. Besides the well-known myrosine, there are also present invertine, amylase, maltase emulsin, and an anaeroxydase.

SYDNEY.

Royal Society of New South Wales, Dec. 1.—**W. G. Woolnough**: The geology of the Flinders Ranges, South Australia, in the neighbourhood of Wooltana Station. The eastern escarpment of the Flinders Range, at Wooltana Station, some 400 miles north of Adelaide, is bounded by a very heavy fault throwing to the east. In the escarpment are exposed rocks of the Adelaide Series (Proterozoic), much better developed than in the type area near Adelaide; Sturtian Glacial Beds attain a thickness of about 1000 feet. They rest upon shallow water or terrestrial sediments, except in one place, where a well-preserved volcanic cone of Proterozoic age is seen. Tapley's Hill Slates (Varves) and Brighton Slates and Limestones follow the glacial series. The topmost beds in the series are red beds, with ripple-marks and sun-cracks, which may have been deposited under desert conditions.—**Edgar H. Booth**: (1) The microphone as a detector of small vibrations. Various military type microphones were examined as to their response to impressed impulses and simple harmonic motions, the detectors being employed with an Einthoven galvanometer. The relationship between thread movement and amplitude of impressed wave is linear for minute amplitudes, and the forms of reproduced and impressed waves practically identical, in the case of certain microphones. (2) Surface waves due to small artificial disturbances of the ground. Waves were produced by dropping a pile driver of mass 0·5 lb. through distances up to 30 cm., the nature and relative amplitude of the waves produced being examined at varying distances from the centre of disturbance by microphones and an Einthoven galvanometer. A value of damping effect for Rayleigh waves for a particular case is given.—**Sir George Knibbs**: Notes on the occurrence of triplets in multiple births. In a previous solution of the probabilities of triplets being produced from one ovum or from two or three ova, it was assumed that triplets were never produced from a single egg. It seems certain, however, that they are sometimes so produced. A probability-analysis, similar to that possible in the case of twins, is not possible in the case of triplets; the numbers produced from one egg must be a matter of observation. Tables are given, however, which show for various numbers of cases of triplets produced from one egg, what the numbers will be of those produced from two or three eggs out of the total of 1489 cases analysed, in which the numbers of males and females were distributed as follows, namely, three males, 343 cases; two males and one female, 390 cases; one male and two females, 395 cases; and three females, 361 cases. It is remarkable that the females are in excess instead of the males. The following illustrates the probable distribution in a total of 1489 cases:

Cases from—						
One egg	0	1	2	20	200	400
Two eggs	1327	1324	1321	1267	727	127
Three eggs	162	164	166	202	562	962

—**A. R. Penfold**: The essential oils of *Eriostemon Coxii* Mueller and *Phebalium dentalum* Smith. The first-named plant has been recorded from one locality only, Sugar Loaf Mountain, near Braidwood, New South Wales. The second is very plentiful in the Port Jackson district of New South Wales. The oils from both were of a pale yellow colour, and possessed a pleasant fruity odour closely resembling that of the passion fruit (*Passiflora edulis*). Their chemical and physical characters were determined.—**M. B. Welch**: An examination of defective New Zealand kauri (*Agathis australis*). New Zealand kauri milled from buried logs obtained from swamps is liable to become worthless due to seasoning defects, the tensile strength being practically equal to the compressive strength. The weakness is evidently caused by a reduction of the strength of the tracheid walls, with the result that they become spirally cracked by the elongation of the bordered pit openings, due to internal seasoning stresses. There is apparently no variation in the rate of absorption or loss of moisture and the ash content is normal.—**F. A. Coombs**, **W. McGlynn**, and **M. B. Welch**: Notes on wattle barks (Part 2). Analyses of barks stored for thirty years indicate that no loss of tannin has occurred, and there is no alteration in the solubility of the tannins. The loss found when solutions of wattle tannins, in contact with partially spent bark, are exposed to high temperatures, is probably due to an insoluble starch tannin combination. This starch tannin compound is soluble at temperatures approaching boiling-point, but separates out on cooling. The high temperatures necessary to overcome adsorption are responsible for the alteration in colour of the tannins.—**W. R. Browne** and **H. P. White**: On the hypersthene-andesite of Blair Duguid, near Allandale, N.S.W. This outcrop of andesite is about 1¼ square miles in area and was formerly regarded as the stump of a volcano contemporaneous with the Lower Marine series of the Permo Carboniferous system. Reasons are given for considering it rather an inlier of Carboniferous lava. The rock has suffered considerable deuteric alteration in places involving albitisation, change of hypersthene into iddingsite, carbonation, etc. Comparison of chemical analyses of the fresh and altered rock indicates the addition of potash as well as soda during alteration.

Diary of Societies.

SATURDAY, FEBRUARY 19.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Newcastle-upon-Tyne), at 2.30.—L. F. H. Booth: Screening and Washing Plant at Deaf Hill Colliery.—W. Rawling: The Economic Working of Thick Seams in New South Wales.—Paper open for further discussion:—The Chemical Relations of the Principal Varieties of Coal. Prof. G. Hickling.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—W. de la Mare: The Supernatural in Fiction.

Physiological Society (at St. Thomas's Hospital Medical School), at 4. —Demonstrations:—Fœtal Respiration in the Goat, by A. St G. Huggett; The Secretion of Bile and Pancreatic Juice following the Injection of Bile into the Small Intestine, by Prof. J. Mellanby.—E. P. Poulton: Tone in Plain Muscle.—J. Needham: Absorption, Combustion and Constitution in the Developing Avian Embryo.—E. M. Boock, J. H. Burn, and J. W. Trevan: The Accuracy of the Assay of Strophanthus and Squill by different Methods.—Prof. J. Mellanby: The Secretion of Bile.

Birmingham Metallurgical Society (at Girls' High School, Dudley), at 7.—R. P. Bethell: Blast Furnace Practice.

Oxford University Junior Scientific Club, at 8.15.—Exhibition Meeting.

MONDAY, February 21.

Victoria Institute (at Central Buildings, Westminster), at 4.30.—Squadron-Leader P. J. Wiseman: Babylon in the Days of Hammurapi and Nebuchadnezzar.

Royal College of Surgeons of England, at 5.—Prof. B. W. Williams: The Importance of Toxæmia due to Anaerobic Organisms in Intestinal Obstruction and Peritonitis.

Institution of Electrical Engineers (Informal Meeting), at 7.—R. O. Kapp and others: Discussion on National Busbars of Central Europe.

Institution of Electrical Engineers (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.—J. H. Reyner: Recent Developments in Radio Reception.

Institution of Mechanical Engineers (Graduates' Section, London), at 7.—F. C. Johansen: The Screw Propeller.

Institution of Automobile Engineers (Glasgow Centre) (at Royal Technical College, Glasgow), at 7.30.—E. W. Seaman: The Straight-Eight Engine.

Aristotelian Society (at University of London Club), at 8.—Prof. A. Wolf: Some Aspects of the Philosophy of Spinoza.

Royal Society of Arts, at 8.—Prof. E. G. Coker: Photo-elastic Measurements of Stress Distribution (Cantor Lectures) (2).

Royal Geographical Society (at Æolian Hall), at 8.30.—Flight-Lieut. G. N. Humphreys: New Routes on Ruwenzori.

Medical Society of London, at 9.—D. Armour: The Surgery of the Spinal Cord and Membranes (Lettsomian Lectures) (1).

Royal Society of Medicine (Social Evening).—P. Flemming: Topographical and Medical Notes on Harley Street.

Chemical Industry Club.

TUESDAY, February 22.

Royal Dublin Society (at Ball's Bridge, Dublin), at 4.15.—E. J. Sheehy: The Correlation of Nutritive Value with the Dry Matter Content of Pastures.—Prof. J. Wilson: The Maintenance Requirements of Cattle on Different Kinds of Rations and at Different Rates of Production.

Royal Institution of Great Britain, at 5.15.—Prof. J. S. Huxley: Problems of Animal Growth and Development (4).

Newcomen Society for the Study of the History of Engineering and Technology (at Institution of Mechanical Engineers), at 5.30.—F. Achard and L. Seguin: The Early British Railways as seen by Marc Seguin in 1825: The Four-cylinder Locomotive 'Chittaprat.'—F. Achard: The First British Locomotives of the St. Etienne-Lyon Railway.

Zoological Society of London, at 5.30.—Lord Rothschild: Exhibition of a Mounted Example of the "Dragon" (*Varanus komodensis*), from Komodo Island, Dutch East Indies.—Major C. M. Ingoldby: Exhibition of Specimens illustrating Climatic Phases of some African Squirrels (Genus Heliosciurus).—R. I. Pocock: Exhibition of the Skin of a new Species of Cheetah.—M. Smith: Contributions to the Herpetology of the Indo-Australian Region.—Dr. J. Waterston: A Remarkable Scelionid (Hymenoptera-Proctotrypoidea) from South Africa.—Prof. A. Meek: *Bipinnaria asterigera* (Echinodermata) from the Northumberland Plankton.—R. I. Pocock: The External Characters of the South African Striped Weasel (*Pœcilogale albinucha*).—Prof. W. B. Benham: External Sexual Differences in the Terebellid Worms.—A Collection of Papers by the following Authors, dealing with the Results of the Cambridge Expedition to the Suez Canal, 1924:—P. Fauvel, W. A. Thorpe, O. Carlgren, Dr W. T. Calman, R. Gurney, V. C. Robinson.

Illuminating Engineering Society (at Royal Society of Arts), at 6.30.—H. N. Green: Artificial Light as an Aid to Aerial Navigation.

Institution of Electrical Engineers (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—Col. E. Mercier: Notes on the 60,000-Volt Underground Network of the Union d'Electricité.

Royal Photographic Society of Great Britain (Scientific and Technical Group), at 7.—F. F. Renwick: Turbidimetry and Grain Size.—W. B. Ferguson: The Ferguson Density Comparator.

Institution of Electrical Engineers (North-Western Centre) (at College of Technology, Manchester), at 7.30.—Prof. W. M. Thornton: What is Electricity? (Faraday Lecture).

Institution of Engineers and Shipbuilders in Scotland (at 39 Elmbank Crescent, Glasgow), at 7.30.—H. Brier: The Application of Pre-cooling by Primary Evaporation and Multiple Effect Compression to CO_2 Refrigerating Machines.

Royal Anthropological Institute, at 8.30.—Prof. J. G. de Montmorency: The Custodian of Tradition.

WEDNESDAY, February 23.

Royal College of Surgeons of England, at 5.—Prof. J. H. Evans: Testicular Tumours of Congenital Origin.

Geological Society of London, at 5.30.—Dr. W. D. Lang and Dr. Stanley Smith: A Critical Revision of the Rugose Corals described by W. Lonsdale in Murchison's "Silurian System."—L. G. Anniss: The Geology of the Saltern Area (Torbay).

Association of Special Libraries and Information Bureaux (at 9 Conduit Street, W.), at 6.30.—G. F. Barwick: Directory of Sources of Specialised Information.

Institute of Chemistry (Belfast Section), at 7.30.—Prof. Gregg Wilson: Primitive Australia.

Royal Society of Arts, at 8.—F. H. Carr: Insulin and its Manufacture.

Electroplaters' and Depositors' Technical Society (at Northampton Polytechnic Institute), at 8.15.—T. Johnson: Electro deposition of Iron.

British Psychological Society (Medical Section) (at Royal Society of Medicine), at 8.30.—Dr. Sylvia M. Payne: Observations on the Formation and Function of the Super-Ego in Normal and Abnormal Mental States.

Society of Chemical Industry (South Wales Section) (at Swansea).

THURSDAY, February 24.

Royal Institution of Great Britain, at 5.15.—Prof. J. Garstang: The Progress of Hittite Studies (1).

Institution of Mining and Metallurgy (at Geological Society), at 5.30.

South London Entomological and Natural History Society, at 7.—Lantern Evening.

Oil and Colour Chemists' Association (at 8 St. Martin's Place, W.C.2).—A. A. Drummond: Further Notes on the Behaviour of Phenolic Resins.

FRIDAY, February 25.

Association of Economic Biologists (at Imperial College of Science), at 2.30.—F. Tattersfield and C. T. Gimingham: Laboratory and Field Experiments on Contact Insecticides.

Physical Society (at Imperial College of Science), at 5.—Sir Ernest Rutherford: Atomic Nuclei and their Transformations (Guthrie Lecture).

Royal College of Surgeons of England, at 5.—Prof. J. E. H. Roberts: The Diagnosis and Treatment of Intrathoracic Tumours.

North-East Coast Institution of Engineers and Shipbuilders (at Literary and Philosophical Society, Newcastle-upon-Tyne), at 6.—R. I. Dodsworth: Loading and Unloading Facilities on Board Ship and Land.

Institution of Mechanical Engineers (Informal Meeting), at 7.—Major W. Gregson and others: Discussion on Waste Heat Recovery.

Institution of Engineering Inspection (at Royal Society of Arts), at 7.30.—C. J. Wharton: The Economic Production of Steam by Electricity.

Junior Institution of Engineers, at 7.30.—Dr. C. M. Walter: A Trip in the Norwegian Fjords (Lecture).

Royal Society of Medicine (Epidemiology and State Medicine Section), at 8.—Dr. N. H. Mummery: The Organisation of an Industrial Clinic.

Institute of Brewing (at Institution of Electrical Engineers), at 8.15.—Prof. H. E. Armstrong: Horace Brown Memorial Lecture.

Royal Institution of Great Britain, at 9.—Prof. D'Arcy W. Thompson: The Solids of Plato and Archimedes.

Manchester Literary and Philosophical Society (Chemical Section).

SATURDAY, February 26.

Merseyside Aquarium Society (at Liverpool University), at 3.—Prof. J. Johnstone: Address.

North of England Institute of Mining and Mechanical Engineers (at Neville Hall, Newcastle-upon-Tyne), at 3.—W. Leebetter: Winning Thin Seams of Great Britain.

Royal Institution of Great Britain, at 3.—Dr. J. B. McEwen: Beethoven (1).

PUBLIC LECTURES.

SATURDAY, February 19.

Horniman Museum (Forest Hill), at 3.30.—Dr. W. T. Calman: The Shipworm, a Pest of the Seas.

SUNDAY, February 20.

Guildhouse (Eccleston Square), at 3.30.—C. Bailey: The Religious Experiences of Ancient Rome.

MONDAY, February 21.

London School of Economics and Political Science, at 5.—Prof. A. Wolf: The General Philosophy of Spinoza.

King's College for Women (Household and Social Science Department), at 5.15.—Dr. E. Barker: Population and its Bearing on National Life and Character.

Royal College of Science (South Kensington), at 5.30.—Dr. W. T. Gordon: The Origin and Structure of Rocks (Swiney Lectures). (Succeeding Lectures on February 25, 28, March 4, 7, 11, 14, 18, 21, 25, 28, and April 1.)

University College, at 5.30.—J. Haantjes: Afrikaans Language and Literature. (Succeeding Lecture on February 28.)

TUESDAY, February 22.

University College, at 5.30.—W. J. Perry: Cultural Anthropology. (Succeeding Lectures on March 1, 8, and 15.)

THURSDAY, February 24.

King's College, at 5.30.—Prof. J. D. Wilson: The Mind: Education.

FRIDAY, February 25.

King's College, at 5.30.—Prof. G. H. Wooldridge and others: Discussion on The Problem of the Humane Slaughtering of Animals.

SATURDAY, February 26.

Horniman Museum (Forest Hill), at 3.30.—C. Daryll Forde: Ancient Ships and their Modern Descendants.

SUNDAY, February 27.

Guildhouse (Eccleston Square), at 3.30.—Prof. J. A. Thomson: The Naturalist's Approach to Religion.

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Industrial and Commercial Efficiency.[1]

MR. RAMSAY MACDONALD, during the brief existence of the first Labour Government, must have established a record in the number of special committees of inquiry which he appointed. Not the least important was the Committee appointed to inquire into the conditions and prospects of British industry and commerce and to make recommendations in regard thereto, the general scope of the inquiry to include a survey of overseas markets, a survey of industrial relations, and an assessment of British productive capacity and its efficiency. The report of the Committee is being presented in parts; the first part, dealing with overseas markets, was published in June 1925; in February 1926 a volume appeared dealing with industrial relations; and now, after an interval of a year, a third volume has emerged as a first of two contributions to the subject of productive capacity and efficiency.

When this Committee was about to be appointed, it may be remembered that doubts were expressed regarding the capacity of a Committee composed solely of representatives of finance, industry, and trade to deal adequately with the proposed terms of reference. Major Church, speaking in the House of Commons to the resolution which led to the inquiry, urged the inclusion of representative scientific workers on the Committee, pointing out that they would be in a better position to estimate the possibilities of future trade developments and to appreciate the effects likely to be produced on our commerce by the applications of science to agriculture—the foremost industry of the Empire—and those industries the future of which is indissolubly bound up with the progress of scientific research, than representatives of the classes of the community specifically mentioned. But Mr. Sidney Webb, on whose advice the Committee was appointed, held to the theory that those who would be chosen to represent science on such a committee would necessarily be creative workers whose time would be better occupied in discovery: consequently, scientific workers were neither represented on the Committee nor have they been given the opportunity of expressing their views on the present relations between industry and science. The Department of Scientific and Industrial Research has dealt with that aspect of the inquiry.

This third volume is disappointing. It consists mainly of reports and memoranda prepared by various government departments or officials. There are a brief half-page summary of the work of the National Institute of Industrial Psychology based on the evidence of the Director, and a chapter on industrial art prepared by the British Institute of Industrial Art. Without further inquiry or reference to other bodies, the Committee has prepared a long introductory, inconclusive summary of the subjects dealt with and views expressed in the remainder of the volume. No recommendations are made, only rarely a hint of a suggestion creeps in for the improvement of industrial efficiency in Great Britain, a complacent air of Micawberish optimism pervades most of the pages, but above all, a veil is drawn over the operations of the banks and financial houses of the country—for the present at any rate. The report gives the impression that all will be well when Great Britain has recovered from the destruction of the new things it created in addition to its normal needs during the War, rather than when it has decided to apply the newest advances in scientific knowledge to industry, under the comparatively unfettered direction of those who understand the creative ideas and forces with which they are dealing.

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[1] Committee of Industry and Trade. Factors in Industrial and Commercial Efficiency: being Part I. of a Survey of Industries. With an Introduction by the Committee. Pp. v+544. (H.M. Stationery Office, 1927.) 5s. net.

Whether the Committee is dealing with industrial structure, the training and recruitment of manual workers and higher technical and professional staffs, standardisation of units of measurement and materials, the function of scientific research, the encouragement of industrial arts, State measures for encouraging home industries and overseas trade, the effect of national and local taxation on certain industries, with all of which this volume deals, it remains entirely non-committal, and the report could be used equally well as a brief either for those who wished to take no action or for those who wished to attempt to improve British industry and trade.

Nevertheless, the memoranda submitted by State departments and other bodies and embodied in this report are of the greatest interest: those on "Industrial Structure" furnished by the Board of Trade, on "Technical Education" by the Board of Education and the Scottish Education Department, and "Industrial Art" by the British Institute, being particularly noteworthy contributions. The chapter dealing with industrial structure gives an account of the marked trend during the last quarter of the nineteenth century towards the limitation of competition in each of the highly industrialised countries and its later development. The information given is already in the possessio of certain sections of the community, but it is th first time, we believe, that it has been summarise in an official publication.

One of the most disquieting features in moder industry is the loss of skill which accompanies th growth of large-scale machine production. Th old traditional crafts, in which the individua carried an article through all stages of its manu facture, are now fast being displaced by mas production, where the individual is responsible fo one of the various processes of manufacture. Th problem of creating and maintaining skill in craft manship is one of the crucial problems of moder industry. For this the Committee supports th view of the Board of Education that we must loo to the schools rather than to the workshop. Th subject of technical training is dealt with at som length. In view of the clamour among certai classes of employers for early vocational trainin the Committee is to be congratulated on expressin its conviction that education is a preparation fo life, and its wider aims and functions should no be sacrificed or subordinated to the demands industry and commerce.

A somewhat gloomy picture is given of the depend ency of Great Britain on the Continental designer for art applied to industry. Too many firms rel entirely upon Paris for their designs and thus ten to limit more and more the creative potentialitie of their own designers. Yet, as it is stated, th artist does not flourish in the ugliness of a norther manufacturing city. "Frenchmen working i Manchester are said to lose their native gifts afte three or four years." The British artist evidentl suffers, like the scientific worker, from lack of a environment congenial to his task, and the narrow ness of outlook of industrial leaders. He suffer from the further disadvantage that the develop ments of the great machine industry had at th outset "the most disturbing and often disastrou effects on industrial art by breaking up the ol craft traditions, revolutionising technique, an weakening or severing the close relations whic previously existed between designer and executant.' Emphasis is laid upon the growing complexity o modern commerce and the obvious need for system atic training in economics and finance. "The fac that the demand for higher commercial teaching o University rank has emanated from economists an educational observers rather than from the repre sentatives of commerce, does not substantiall weaken the case for such education, for almos exactly the same observation could have been mad a generation ago with regard to forms of technical and scientific instruction which have now become firmly established."

In dealing with the subject of scientific research the Committee has relied upon the memorandum furnished by the Department of Scientific and Industrial Research. Other government departments which might have made equally useful contributions to the subject have not been given the opportunity of presenting their views, and apparently the views of leading manufacturers have not been independently ascertained. The Committee states what scientific workers have long known to be the case, that there is still a very imperfect recognition by the industries of the need for the continuous and systematic application of scientific methods both to the invention and improvement of particular methods and processes of production, and to the enlargement of the boundaries of knowledge with regard to the fundamental underlying principles. Most of the scientific workers engaged in industry are absorbed in "tactical research," that is to say, the improvement and development of existing processes, and very few in "strategical research," *i.e.* the search for new products or processes or to the investigation of fundamental laws. The cost of strategical research is usually beyond the means of individual firms, and only the great combinations can afford to embark on such enterprise. The Committee is forced to the conclusion that "freedom and flexibility are essential conditions of fruitful research" and urges the need for the demarcation of functions in the matter of research between the State, which could and should encourage this freedom, and private enterprise, which will usually have a tendency towards secrecy.

It is unfortunate that the Government which appointed this committee did not adopt the suggestion made to bring the representatives of science in intimate contact with the leaders of industry and finance. Had this been done, the chapter on research might have concluded with definite recommendations instead of vague generalities and aspirations. But the fault lies with scientific workers. They fail to realise the urgent need of putting themselves in a position to demand representation on all such bodies. Though faced with every form of combination among financiers, employers, and manual workers, they neglect to combine themselves for the furtherance of their legitimate interests; and while they remain unorganised they can scarcely expect to be considered as a driving or united force in public affairs which affect them as well as the nation.

Evolutionary Philosophy.

Holism and Evolution. By General the Right Hon. J. C. Smuts. Pp. ix + 361. (London: Macmillan and Co. Ltd., 1926.) 18*s.* net.

THE advance, and indeed the proper comprehension, of evolutionary philosophy is to-day suffering greatly from the increase of specialism. This specialism is to a great extent inevitable, but it is at least in part due to an unfortunate by-product of the spreading appreciation of the value of research. The educationist realises that there is no finer training than that which is gained by the conduct of a piece of original investigation. The community as a whole, too, is beginning to appreciate, even though dimly, the extent to which scientific research enters into the foundations upon which rest the health and comfort and prosperity of the modern civilised state.

While this growing appreciation brings with it advantage to the cause of science and to the welfare of mankind, it is not without its disadvantages. Young men without conspicuous natural qualifications are turned on to do a bit of research for their own personal advantage. This is all to the good: they are bound to benefit greatly by being put through the necessary discipline. The harm comes when such prentice efforts are published without due consideration. The work may be simply of inferior quality, or if sound it may be that poor kind of research which consists merely in the transference of certain facts in Nature, of no apparent significance, to the pages of a printed book or journal. Above all, there is the natural tendency, and not merely for beginners, towards intensive research in some very restricted field. The myopia induced by such intensive study necessarily involves disability to broader vision—a disability of which the patient is often completely unconscious—and we find the narrow specialist laying down the law as regards the problems of evolutionary philosophy in a way which even an elementary grasp of those portions of the subject lying beyond the limits of his own speciality would restrain him from doing.

In General Smuts we have a visitor to the domain of biology from very different fields of activity, and as he comes armed with credentials of the highest order—testifying to his intellectual power, to his honesty of purpose, and to his remarkable freedom from prejudice—it becomes of extraordinary interest to scan his vision of evolutionary philosophy, free as it is from the distortion and disturbance of true proportion which specialist concentration on little bits of the subject is so apt to induce.

The first four of the twelve chapters of "Holism and Evolution" are devoted to those fundamental concepts which underlie the general theory of evolution, to the ideas of space and time and matter, and to the cell and the organism. To the present reviewer, who believes that the lapse of time—with the truer proportions that distant vision gives—will show the figure of Charles Darwin towering alone above all others in the history of philosophy, it is particularly agreeable to see that General Smuts appreciates, in a way that the biological specialist so often entirely fails to do, the unique position occupied by Charles Darwin.

While emphasising in this introductory portion of the book the importance of increased precision of nomenclature, it is perhaps disappointing that the author has not handled the tangle in which so much modern discussion has become tied up in the misuse of the word 'space.' The conception of space is derived by a simple step from the sensory perception of the extension of material objects, by merely ignoring the material substance of which they are composed. That gives us the primitive idea of space, and this space is in its essence tridimensional. When the pure mathematician for his own purposes modifies this idea by removing or adding one or more dimensions, we are apt to forget that in doing so he has interfered with the fundamental conception of space as derived from our sensory experience of the material world. No harm is done in the realms of pure mathematics: the danger comes when such expressions as 'space' of one, or of two, or of *n* dimensions, are brought back into speculations regarding the material universe, for confusion of ideas is the immediate and inevitable result.

In the following chapters of his book the author develops his philosophy of Holism. "The close approach to each other of the concepts of matter, life, and mind, and their partial overflow of each other's domain, raises the question whether back of them there is not a fundamental principle of which they are the progressive outcome."

Evolution to the author is not the process expressed by that word taken literally—a mere unfolding of complexities already present—but is actually creative: "it creates both new materials and new forms from the synthesis of the new with the old materials." Surveying the world of Nature, the author sees its great characteristic in the tendency to the development of 'wholes.' To illustrate what he means by wholes, he cites the case of living organisms, each made up of constituent parts but yet possessing an individual specific character of its own. Although particularly obvious in the case of animals or plants, such wholes pervade all Nature—not merely the material world with its atoms, molecules, and chemical compounds, but also the immaterial world which includes human ideals and performances. Everywhere we find 'wholes' basic to the character of the universe, and "Holism as the operative factor in the evolution of wholes is the ultimate principle of the universe."

This, then, is the kernel of General Smuts's philosophy—that the universe is vitalised by a great driving force—its inherent tendency towards integration into more and more highly developed wholes, into the more lowly types seen in inorganic Nature, the higher types seen in living creatures, and finally the highest types of all on the artistic and mental and spiritual plane of existence. "Holism in all its endless forms is the principle which works up the raw material or unorganised energy units of the world, utilises, assimilates, and organises them, endows them with specific structure and character and individuality, and finally with personality, and creates beauty and truth and value from them." A great idea surely, and one which justifies the author in putting forward his claim that it brings us nearer "the monistic conception of the universe which is the immanent ideal of all scientific and philosophical explanation."

In a series of interesting chapters the theory just outlined is elaborated, one of the most interesting being that entitled "Darwinism and Holism." Here again full tribute is paid to the greatness of Darwin: "He has changed our whole human orientation of knowledge and belief, he has given a new direction to our outlook, our efforts and aspirations, and has probably meant a greater difference for human thought and action than any other single thinker."

Perhaps still more remarkable than the author's appreciation of Darwin is the fact that he has succeeded in maintaining his balance in regard to Mendelism, and has firmly placed it in proper perspective in relation to the general theory of organic evolution.

An acute discussion of Weismann and his work leads to the much-debated question of the inheritance of impressed characters, in which the author shows a distinct leaning towards accepting their transmissibility, incidentally testifying to the impression made upon him by Bower's discussion of the matter in relation to evolution in the vegetable kingdom. Repeatedly we come across the suggestion that such impressed or 'acquired' characters *may* be inherited. The position taken up, however, by those of us who feel constrained to keep such characters outside our evolutionary speculations, is not that we dogmatically deny that they *may* be inherited, but rather that we deny the existence of the overwhelming body of evidence that they *are* inherited, which we believe would inevitably be forthcoming were this the case.

An interesting feature in this chapter is that the author shows that he fully realises the prevalent error of thinking of small variations in detail by themselves, and stumbling over their selective value, instead of bearing in mind that these details are merely parts of a physiological whole and that the actual selective process deals with such complete individuals.

It is very true, and it is, in these days, really necessary to drive it home, that "there is no doubt that experimental evolution has, through its unavoidable limitations, greatly blurred the great Darwinian vision of organic evolution," and "natural evolution as distinguished from experimental evolution is a process, not of the hour or the day, but of geological time, and the results, consolidated through immemorial periods, cannot be repeated or rehearsed by short-dated laboratory experiments."

What Darwinism does not explain, or purport to explain, is the origin of the variations which form the raw material upon which natural selection works. To the present reviewer that raw material is provided by the instability or variability which is essential and inherent in the nature of life itself. To the author of Holism it is given by a universal tendency to undergo change in the direction of higher and higher integration.

As regards the general thesis of Holism, probably most men of science will find themselves in agreement with the author so far as the evolution of the universe as a whole, meaning by that the sum of all existence, is concerned. There must have been inherent in that from the beginning a creative power which has found its expression in all subsequent developments. Some, with General Smuts, will spell it Holism: some will spell it God.

Many, however, while accepting the argument for the universe as a whole, will feel doubts as to their being constrained to do so for its constituent parts. When dealing with any one of these we are no longer dealing with something that is absolutely self-contained: it now has an environment; and the doubt arises whether the environment, taken in conjunction with the instability which modern physics would appear to extend even to the minutest particles of 'dead' matter, may not have a moulding influence sufficient to account for evolution.

Enough has perhaps been said to achieve the purpose of this review—to direct attention to a remarkable and important work which should be read by all interested in the philosophy of the world in which they live. As will have been gathered, General Smuts' book is a step towards that merging together of science and philosophy which is bound to come at no distant date. Men of science and philosophers alike are aiming at the same objective—the unravelling of the meaning that lies behind phenomena.

Such basic ideas as space and time are no longer placed apart as *a priori* in their nature: it is realised that each is a simple development from sensory experience. The man of science believes that, with the foundations of his philosophy laid in experience, he is logically bound to keep in touch with experience throughout the whole process of building up that philosophy of the universe in which he lives. He realises that as he builds he must make use of every possible refinement of technique, whether of observation or of mathematical or other methods of working up the data obtained by observation. With both sets of workers striving onwards towards the same goal, it will not do for either to ignore any methods of technique that will help them on their way, and when once this is fully realised and a common technique adopted, we shall have at last a unified army marching onwards to the attack of ignorance, and it will be of little moment whether its banner is inscribed 'science' or 'philosophy.'

J. GRAHAM KERR.

The Geology of Siberia.

Fortschritte der Geologie und Paläontologie. Herausgegeben von Prof. Dr. W. Soergel. Heft 15: *Geologie von Sibirien.* Von Prof. Dr. W. A. Obrutschew. Pp. xi + 573 + 11 plates. (Berlin: Gebrüder Borntraeger, 1926.) 37·50 gold marks.

GEOLOGISTS will be deeply grateful to Prof. Obrutschew for his masterly summary of the geology of Siberia, since so much of its extensive literature is in Russian and therefore inaccessible to most western workers. His book will form a standard work of reference for the geology of northern Asia, owing to its concise summary of the available information, its clear discussion of the chief stratigraphical and tectonic problems, its admirable series of sketch maps, and its full bibliography.

Prof. Obrutschew divides Siberia into seven geomorphologic units, including the *Scheitel* of Suess, to which he refers as the *kern*, and therefore justifies the translation of the term as core or nucleus. He prefers to call this area the Sayan-Baikal Highlands, but Suess's explanation of its significance is confirmed, as the Jurassic and Kainozoic deposits upon it are horizontal. The most serious modification in Suess's interpretation of the structure of Asia is in connexion with the Altaids; Prof. Obrutschew shows that Suess has included in his Altaid Mountain Systems elements of different ages, trends, and origin. Some of the east Altai folds are Caledonian, and some, such as those of the Saur-Tarbagatai and the Tien Shan, are later. Prof. Obrutschew therefore excludes the Tien Shan ranges from the Altaids and restricts that term to the Altai, the Khirgiz folds, and the Siberian Hercynian movements. Suess's objection to the term Hercynian, however, still stands, and his suggestion of Altaid as the name for the widespread mountain system that was formed toward the end of the Palæozoic and includes American, European, and African as well as Asiatic mountains, remains unshaken by these restrictions.

In the long succession of marine deposits in Siberia most of the geological systems are represented, and they throw light on many problems. Thus, in reference to the current discussion upon climate and continental drift, it is interesting to note that the Siberian marine faunas from the Cambrian to the Upper Kainozoic all have features indicative of a northern zone. The fauna which suggests the warmest conditions is that of the Silurian, which is described as being rich in corals; but they are mostly either simple or Alcyonarian, and do not indicate such warm conditions as rendered possible in England the growth of the contemporary coral reefs and those of the succeeding Devonian. The Tethys once spread northward so far as the Siberian Islands, but its fauna there consisted mainly of ammonites, and was consistent with a moderately cool sea. In the Cretaceous, which is so often claimed as having had an Arctic tropical climate, the marine fauna was rich in Aucella, and the one coral quoted from Siberia is a simple form, a Microbacia, and these fossils might have existed in a sea as cold as the present Arctic Ocean.

The work follows quite different lines from the recent discussion by Prof. Argand of the tectonic of Asia. It is a summary of the facts with such discussion as is required to make them intelligible and interesting, and will be an indispensable book of reference in regard to Asiatic geology.

J. W. G.

Behind the Divining Rod.

The Divining-Rod: an Experimental and Psychological Investigation. By Sir William Barrett and Theodore Besterman. Pp. xxiii + 336 + 12 plates. (London: Methuen and Co., Ltd., 1926.) 18*s*. net.

SPECIALISATION in science, and the organisation of research, undoubtedly lead to rapid advance in the elucidation of particular groups of phenomena; but they are also responsible for systematic neglect of others. Thus there remain dark corners into which the investigators of the last century swept the trifles which they preferred to leave unconsidered.

For a hundred years after Cavendish had shown that a portion of atmospheric nitrogen, after being 'sparked' with oxygen, always remained uncombinable, chemists deliberately ignored this residuum; yet soon after Rayleigh and Ramsay turned their attention to it, the sky-signs of London were advertising by the glory of their colours that there was indeed something in it. When this has been possible in chemistry's diligently cultivated field, may we not hope to find much more lurking in those obscure places where none of the recognised sciences has as yet pegged out a claim?

The use of the divining-rod in the discovery of springs has long been looked at askance by men of science, and not altogether without reason. People who profess to be dowsers, though usually honest folk, are sometimes fools deserving the application of their rods to their own backs, as Prof. C. V. Boys hinted in these columns a quarter of a century ago. Occasionally they are pernicious paradoxers or, rarely, unblushing impostors; yet it must be acknowledged that none of those who essayed to prove that there was nothing but folly, perversity, and imposture in this method of water-finding, has succeeded in explaining the unquestionable facts. Every one who has had to do with the water-supply of country houses knows that dowsers do find water. To ignore problems for fear that their solution might involve methods beyond the domain of conventional physics is no more justifiable than would be the banning of research into protons and electrons lest it should lead the investigator beyond the sphere of Daltonian chemistry.

Many years ago Sir William Barrett defied scientific prejudice and took up the study of dowsing. He devoted so much time to the divining-rod in literature and in practice that a systematic statement of his results has been awaited with interest and curiosity. Unfortunately, he died without completing the classification and discussion of the mass of data in collecting which he had written, as the preface tells us, between 6000 and 7000 letters. Some months before his death, he had secured the co-operation of Mr. Theodore Besterman, with whom he discussed the whole subject, though for the actual arrangement and writing of the book before us the junior colleague accepts full responsibility.

Although the book makes very interesting reading, its arrangement is far less satisfactory than the orderly subdivision in the table of contents might suggest. Mr. Besterman devotes 250 pages to evidence of the reality of the finding of water (and incidentally other things) by the divining-rod, and only about 50 pages, many of them straying back to the earlier theme, to an attempt to explain the mechanism and rationale of the process. The work is divided into three parts. Part I. is entitled "Historical and Geological." The historical portion, after touching on the rise of dowsing in the fifteenth century, gives interesting details of the performances of three famous French dowsers for minerals and water and the tracking of criminals. It includes the strange case of the Abbé Paramelle, a water-finder who used no divining-rod and disclaimed any super-normal powers, yet the authors have decided that he was a dowser *malgré lui*. Much of the geological discussion strikes us as irrelevant and unnecessary, it being clear that none of the famous dowsers had any geological knowledge whatever and could not have located water by the lie of the sub-surface rocks.

Part II., though entitled "Experimental," consists of descriptions of the exploits of a large number of recent and contemporary water-finders similar to that given in Part I., with details vouched for by numerous well-known or highly respectable authorities. Three appendices cite other cases which might appropriately have come in Parts I. and II. Even the short "Part III., Theoretical," continues to adduce fresh evidence as to successful dowsers while setting forth the explanation of the action of the divining-rod arrived at by the authors. There is an excellent index, which will prove useful to students of the subject, and an extensive bibliography, which might have been improved by providing some indication of the size of the books cited.

As to the value of the whole discussion, Mr. Besterman says in his preface:

> "Whether the results justify this labour it is for the reader to decide; but should it be agreed that the ability to find hidden objects by other than normal means has been established, the question can hardly be answered otherwise than in the affirmative."

This is not happily worded, for it fails to define the critical term *normal*, and by extending the use of the divining-rod from the well-established case of water-finding to the detection of minerals, corpses, and even murderers, it makes room for the intrusion of false issues. Sir William Barrett probably went beyond the comparatively simple case of the divining-rod in water-finding because he hoped to reach in one stride an explanation which should include all kinds of cognition of objects undetectable by the 'five senses.' We agree that the evidence brought forward in the book proves the existence of a power in some people, of both sexes and of every age, race, and social position, of detecting underground springs of water which can neither be seen, heard, smelt, felt, or otherwise perceived by the vast majority of mankind. Further than this we are not prepared to go, nor do we think it necessary to seek more recondite explanations until all reasonable hypotheses for bringing the phenomena into line with the recognised or discoverable processes of Nature have been exhausted. The suggestion that radiation or vibration of some kind issuing from running water underground may be detected by the nervous system of the dowser in virtue of some hyperæsthesia is dismissed too curtly (p. 261) as "terminological perversity." The comprehensive explanation which Mr. Besterman tenders in the names of Sir William Barrett and himself (p. 267) to cover all cases of the dowser's detection of hidden things is:

> "The several categories of phenomena surveyed above appear to us to lead inevitably to the conclusion that no physical theory can cover the facts. In our view the phenomena of dowsing are due to the following causative chain of psychological and physiological happenings: a suggestion is received by the dowser's subconsciousness by means of a sensibility as yet unknown to us and therefore admirably named by M. Richet cryptesthesia; . . . the knowledge thus supernormally obtained can become conscious: . . . (1) if the person is one whose access to, and ability to become conscious of, knowledge in his subconsciousness is more continuous and complete than those of the normal person, the cryptesthetic suggestion received by his subconsciousness can almost simultaneously become conscious. . . . (2) By means of unconscious, automatic movements such as those which provide the phenomena of automatic writing. . . . Intermediately between these alternatives may be placed (3) those reactions of the subconscious suggestion which cause the phenomena which may be comprehensively described as the *malaise* of the dowser."

Here a fallacy may lurk, for if "a sensibility as yet unknown to us" is conjectured as conveying cognition to the subconscious whence it obscurely wriggles into the conscious mind, could the unknown sensibility not be as easily conjectured to appeal direct to the conscious mind? If cryptæsthesia is a "sixth sense," as M. Richet suggests, may it not be a sense capable of appreciating directly some physical property of the hidden object? This appears to be Prof. Richet's own view if we translate rightly his letter in Nature for Dec. 18 (p. 876) on the explanation of "spiritualistic" phenomena:

> "The hypothesis of unknown *vibrations* seems to me preferable. After all, why not suppose that reality emits vibrations? Do we not know of innumerable powerful vibrations such as electric and magnetic waves which are only revealed by special detectors and would pass unperceived without the use of these detectors?"

Thus Prof. Richet seems to countenance the idea which occurred to us, before his letter appeared, in reading Sir William Barrett's book, that the *malaise* of cryptæsthesia may be akin to that experienced by some people in thundery weather, which can reasonably be attributed to the action on the nervous system of the electric waves announced by wireless 'atmospherics' in advance of thunderstorms. Investigation must prove whether this is so, or if the recognised senses may in some people attain a state of hyperæsthesia and become capable of acting much more powerfully than under usual conditions. May not some people have a sense of smell (if it is smell) as highly developed as that of the dog which perceives in the dark outside a house the room in which his master is; or a sense of hearing or touch as fine as that of the bat, if that animal indeed navigates dark winding caverns by means of a natural power of echo-sounding?

It may be the prejudice of the student of measurable and calculable things which makes the hypothesis of cognition through the unconscious mind repugnant as an instrument of scientific research, or it may be ignorance of psychological methods which makes us incapable of being convinced by the arguments, while accepting the facts, brought forward in this book. Whether his explanation is right or wrong, Sir William Barrett deserves to be held in grateful memory for accumulating by his enthusiastic labour such a rich store of obscure facts. It is to be hoped that the book will inspire some open-minded investigator versed in physiology and adequately instructed in physics and psychology to make an exhaustive experimental study of the mechanics of the divining-rod and the concurrent physical and mental state of the dowser, with the sole object of seeing how it is done. Observers who take up the subject determined to prove that the whole thing is a piece of humbug, can of course discover nothing.

Hugh Robert Mill.

Our Bookshelf.

The Subject Index to Periodicals, 1922. Issued by the Library Association. *K: Science and Technology.* Pp. 136. (London: Grafton and Co., 1926.) 21*s.* net.

We welcome the appearance of this new part of the "Subject Index to Periodicals" dealing with periodical literature relating to science and technology published in the year 1922. The delay in issuing the volume, however, is very regrettable, the more so since there appears to be little improvement in this respect as successive volumes are produced. The interval of from four to five years which has to be made good by the user of the "Index" to bring his search up-to-date means a serious addition to his labours, and from the point of view of the publishers must undoubtedly tend to hinder an expansion of the subscription list to a degree commensurate with the value of the work offered. Since the interval is now so large, we are inclined to think, provided, of course, that the necessity of bridging the gap as soon as possible be kept steadily in view, that it would be better for the editors to proceed at once with the work on last year's journals so that this could be issued during the current year, and the annual volume thereafter be kept close on the heels of the material covered.

Apart from this, the present volume worthily maintains the reputation of former issues. Some 250 journals are indexed, and the entries are allotted to a very large number of headings covering a wide field, and arranged, as usual, in alphabetical order. Some readers may perhaps derive amusement from the juxtaposition of such headings as *Omnibuses* and *Onions*, but there is no doubt that an index of this description provides for much quicker reference than one arranged on any other system, and when the choice of headings, the allotment of the different entries, and the provision of cross-references, are carried out as carefully as they are in these excellent volumes of the Library Association, there is room only for satisfaction. The inclusion of a list and particulars of the journals indexed would be a great convenience.

Agricultural Research in 1925. Pp. vii + 174. (London: Royal Agricultural Society of England, 1926.) 2*s.* 6*d.* net.

The scope and purpose of this work is sufficiently explained by the following extract from the preface: "There is need for a new publication which would record, in a concise form, and in language easily understood by the non-scientific, but practical, man all the results of scientific work carried out, not only in Britain, but in other parts of the world, so far as it has bearing on agricultural practice at home." This preface is signed "Devonshire, Chairman Research Committee, Royal Agricultural Society of England." There follow five compilations by recognised authorities on each subject, dealing specially with research 'results' in veterinary medicine, soils and manures, animal nutrition, dairy husbandry, agricultural economics, and agricultural engineering.

No one can quarrel with the merits of the work; each section will certainly prove of interest to research workers in each particular field. But doubts may be expressed as to its intelligibility to the "non-scientific *but* practical man" (the italics are ours—the antithesis is, we hope, unintentional). Much of the language used implies some knowledge, not only of strictly scientific terms (such as metabolism), but also of ideas expressed in an ordinary language (*e.g.* energy) with which the 'practical' man is not familiar. Be that as it may, the names at the head of each section are a sufficient guarantee that the information given is trustworthy and that the praiseworthy objects of the leading agricultural society in Great Britain have been worthily achieved.

A Road to Fairyland. By Erica Fay. Pp. vii + 219. (London and New York: G. P. Putnam's Sons, Ltd., 1926.) 5*s.* net.

"A Road to Fairyland" is dedicated to "all children between the ages of seven and seventy," and the author has indeed provided a variety in her twelve stories in which something should please her clientèle at every stage within these limits of their years. Here and there we catch an echo of the folk tale; but the author has a subtle power of invention and a felicity of phrasing, as well as a humour, now delicate, now broad, which have carried her well on the way to success in the bold and risky undertaking of writing fairy tales. One feature in these stories may be held by some to be open to question. In most of them a moral is to be discerned, and sometimes it is explicitly stated in the good old-fashioned way at the end. The moral has long been condemned; but the healthy normal child does usually love a moral. It is infancy's equivalent to the triumph of virtue in the melodrama of days gone by. Of individual stories, the one with which the book opens, "The Princess," is perhaps the best. It exhibits a knowledge of human nature and a philosophy which makes the best of things that lift it to a higher plane. Palæontologists and metaphysicians with a sense of humour—if there are such—will appreciate the picture of a sabre-toothed tiger in Kent's Cavern being helped to his human dinner by a stalactite, which in so doing sacrifices its devotion to the absolute to gratify a desire for revenge on the human race. It will be seen that the author is something of a philosopher in the style of Andersen—no mean model.

Lime in Agriculture. 1: in Plant Nutrition, 2: in Animal Nutrition; a Handbook for Practical Farmers, Students, and Others. By Frank Ewart Corrie. Pp. xi + 100. (London: Chapman and Hall, Ltd., 1926.) 3*s.* 6*d.* net.

Lime deficiency is generally recognised as one of the main factors causing poor crop yields, but unfortunately in too many cases little or no attempt is made to remedy matters. This is partly due to a failure to realise the considerable improvement that is likely to be made by a judicious lime application, and partly to a lack of knowledge as to the best and most economical materials to use. The author has endeavoured to outline the problem in the simplest manner, emphasising the need for lime in both plant and animal nutrition, and supporting his remarks by reference to the results of modern research work. A very useful feature is a descriptive list of the various forms in which lime may be applied, as the expenses of carriage usually compel the use of the nearest source of supply. The benefits that crops derive from adequate lime are given, but no mention is made of the effect of chalk on heavy land in reducing the resistance offered to the passage of cultivation implements. On the animal side, the nutritive requirements of various classes of stock for lime are considered, together with the sources of supply, as milk, hay, and green fodders, meat and bone meals and fish meals. An appendix gives a series of illustrative analyses, including some of soils deficient in lime, various types of lime that may be used, lime deficiencies in rations, and the lime and phosphatic acid contents of foods.

Practical Photo-Micrography. By J. E. Barnard and Frank V. Welch. Second edition. Pp. xii + 316. (London: Edward Arnold and Co., 1925.) 18*s.* net.

Fourteen years have elapsed since the first edition of this book was published, but it is noteworthy, as the authors point out, that photo-micrography itself has made little advance during this period, though there have naturally been various modifications in the apparatus employed. The reason for this standstill is that microscopy has not advanced, for the best microscopes and miscroscopic objectives of twenty or more years ago are equal to any produced to-day.

After a brief summary on the microscope and its optical parts, illumination is dealt with. It seems scarcely necessary now to enter into such full detail respecting calcium carbide as is done, and no mention is made of paraffin and petrol mantle lamps, which in country districts may be of some service and are useful for printing on 'gas-light' papers in the absence of gas and electric light. The chapters on cameras, the use and manipulation of the microscope, colour screens and exposure, and photographic processes, are excellent, and the authors are able to incorporate many useful 'tips,' the result of their experience. Finally, the illustrations are adequate and clear, and a series of beautiful plates show what may be done by means of photo-micrography.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Future of the Natural History Museum, South Kensington.

IN reference to the expression on the part of Prof. Stanley Gardiner and others (see the *Times*, Jan. 13) of a desire for the assignment of an increased grant of public money to the institution known as "the Natural History Museum" (or more correctly as "the Natural History Departments of the British Museum"), will you allow me to say that whilst I share their wish and hope for this increased expenditure, I am strongly of opinion that no such increase should be made until the status, purpose, and organisation of this museum and other related institutions have been made the subject of a thorough and authoritative inquiry, and consequent recommendations by a Royal Commission appointed for the purpose? One or two matters which require the attention of such a commission have long occupied my thoughts, and I should like to indicate briefly what they are without entering at this moment into a discussion of details.

1. The most important point for such a commission to consider is, I think, the establishment of the Natural History Departments as an independent organisation—the "Natural History Museum" or "British Museum of Natural History"—under its own Council, 'Director,' and heads of departments, receiving an adequate grant from the Treasury, and reporting directly to a Minister of State and not to the 'Trustees' of the National Library and departmental collections of ancient and medieval art and anthropology.

2. Such a commission should give an authoritative statement of the scope of the Natural History Museum with a view to its immediate organisation and its future growth and development. No such agreed statement exists. There are two distinct purposes which should (it seems to me) be made by statute equally binding on the administration of the Natural History Museum, namely, (*a*) the 'edification' and instruction of the public by means of exhibition of carefully chosen and prepared specimens, and (*b*) the safeguarding and increase of the vast series of specimens of all kinds of living things from all parts of the world which are the indispensable 'documents' by reference to, and study of, which the biological sciences acquire far-reaching importance.

3. By judicious selection of the specimens to be permanently exhibited to the public with the most effective illumination and display, accompanied by skilful labelling and explanatory illustration, the actual floor-space now occupied by the public exhibits in Cromwell Road could be reduced to one-half of its present dimensions and the enjoyment afforded to the public in no way diminished. At the same time, the space thus set free could be used for the better accommodation of the reference collections and for the necessary 'work-rooms' required by the experts who continually add to the collections and maintain them in a proper state of conservation and order. They publish (under the Museum authority) accounts of new and important additions to knowledge. These publications are made by the staff of the Museum, and also by voluntary workers whose co-operation is welcomed by the official staff.

4. I will venture no further at the present moment than to suggest in the briefest terms some developments of the activities of the Natural History Museum which a Royal Commission might be asked to consider. Thus, for example, since there is, in the judgment of leading zoologists, a need for increased accommodation and expenditure in order to give needful help to the various branches of zoological science at the Natural History Museum, one is led to inquire as to whether it is reasonable to maintain there a Department of Botany, when so splendid an institute of botany is also maintained at the public expense at Kew Gardens. I will not attempt to state either the history or the justification of the existing arrangement. But it is obvious that, were the Botanical Department removed from the Natural History Museum to Kew, a very considerable space would be available for the expansion of the other departments of the Museum. Probably somewhat complicated legislation would be necessary to bring about the completion of Kew by the fusion with it of the Botanical Department of the Natural History Museum. The question worth consideration is whether such a fusion would promote the growth of botanical science.

5. A few words will serve to indicate some other developments which might be submitted to a commission. There is no truly *geological* museum in London. The Geological Department of the Natural History Museum has magnificent and invaluable collections of fossil vertebrates and invertebrates. But they are not there to serve the purposes of the investigator of geological phenomena. They are the records of palæontology. Many men of science would like to see a real museum of the 'geology' of the world, topographical and stratigraphical (not limited as is that of the Geological Survey), fully set out at the Natural History Museum. Another collection which has, by the chapter of accidents, been insufficiently developed at Cromwell Road is that of osteology—the skeletons of vertebrate animals. The fact that the Royal College of Surgeons has a fine series of osteological specimens has led to the relative neglect of this important branch of study by the Natural History Museum. Of late years efforts have been made to remedy this, but space, money, and time are necessary for the assemblage of such a comprehensive collection of osteological specimens as are needed by the modern zoologist, and could only be secured and preserved for reference and study by a great and wealthy museum.

I may just raise another question. Should there not be within the walls of the Museum a lecture-theatre to hold some 200 visitors, where lectures and demonstrations, by means of photographs and lantern, could be given at regular intervals by the Director and lecturers called in by him? The purpose of the lectures would be specially to illustrate and explain the contents of the public exhibition galleries. Copies of the photographs made for the lectures, might be sold at the book-stall of the Museum. The lectures would deal with such subjects as "The Classification of Animals," "The Origin of Species," "Geographical and Geological Distribution," "Variation," and "Heredity." Also "Recent Additions to the Museum" should be shown to the public at regular intervals by special lectures.

Lastly, as to expenditure on expeditions and collecting. The Natural History Museum has for many years given assistance to travellers and explorers by "working out" their collections, and often by purchasing specimens or whole collections. Prof. Stanley Gardiner is anxious to extend this line of activity. It is a difficult matter to deal with, since official and private interests and purposes are involved. There is

an obvious way by which important new collections and special specimens may be obtained for the Museum and for the public benefit. There was in 1912 (and possibly still is) in Berlin a Society of the "Friends of Natural History." They were rich men anxious to obtain new and important specimens for the National Museum of Berlin. In 1912 they put down £10,000 and sent five hundred negroes to Tendaguru, fifty miles from the coast of German East Africa, in order to collect the bones of certain gigantic extinct dinosaurs which had been discovered there. They brought these bones successfully, carefully packed in plaister and soft wrappings, to Berlin. Their discoverer, Dr. Fraas, named the largest of these great reptiles 'Gigantosaurus.' Its femur is ten feet in length. Tendaguru is now British, and further collecting of dinosaurs' bones is being carried on by an English party. It seems to me that zoologists should endeavour to set up a society like that of the German "Friends of Natural History." Such a society exists in Great Britain for the purpose of purchasing works of art for the National Collection. The society, by offering to *help* in expenditure for the national collections, might (and in art matters, I believe, does) induce the authorities to make desirable purchases. Our lovers of natural history should follow the example of the Berlin Society and of the English friends of art.
E. RAY LANKESTER.

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The Genesis of the Great Nebulæ.

WITHIN the mesh of our local star-system are nebulæ of irregular shape, such as the Orion nebula, which are of only slight cosmogonic interest. Far beyond the confines of this local star-system lie the great nebulæ of regular shapes, spiral, elliptic, circular, etc., each of which is comparable in mass and size with our whole star-system. In the December (1926) issue of the *Astrophysical Journal*, Dr. Hubble paints a most fascinating picture of the system formed by the great nebulæ, and frames it in such convincing observational evidence that it would be difficult to reject it.

As seen in a telescope, the great nebulæ differ widely in shape, size, and brightness. But Dr. Hubble brings a mass of evidence to prove that differences in size and brightness between nebulæ of the same shape are almost entirely due to a distance effect. If all the nebulæ were put in a row at the same distance from us, it would at once be seen that nebulæ of the same shape all had approximately the same dimensions and luminosity, while even nebulæ of different shapes would exhibit only comparatively small ranges of dimensions and luminosity, especially the latter.

This makes it possible to estimate the distances of all nebulæ, even the very faintest, with fair accuracy. The faintest which can be observed photographically in the 100-inch telescope are of about 18th magnitude, and these must be at the amazing distance of about 140,000,000 light-years. Within this distance some two million nebulæ must lie. Dr. Hubble finds that these are fairly uniformly spaced at an average distance of about 1,800,000 light-years apart. To construct a model, take 20 tons of walnuts and space them at about 25 yards apart, thus filling a sphere of about a mile radius. This sphere is the range of vision of the 100-inch telescope: each walnut is a nebula containing matter enough for the creation of perhaps a thousand million suns like ours; each atom in each walnut is a solar system with a diameter equal to that of the earth's orbit.

With minor exceptions, all the different shapes of nebulæ can be arranged to form one continuous sequence, and this sequence is almost certainly evolutionary. Indeed, to my great gratification, it coincides almost identically, as Dr. Hubble remarks, with the evolutionary sequence I predicted for nebulæ, on purely theoretical grounds, in 1917 ("Problems of Cosmogony"). An initial sphere of gas gives place first to an oblate spheroid, and then to a lenticular figure. After this last configuration is passed, gas streams away from the nebular equator, generally in two symmetrical streams or arms. Granulations and condensations next begin to develop in these arms, each condensation ultimately forming a separate star, until finally the whole nebula is transformed into a star-cloud. Thus the great nebulæ prove to be the birth-places of the stars.

Long before I was able to trace out this complete evolutionary sequence, I had been able in 1901 to take a step in the reverse direction, and show that the stars had in all probability been born out of a uniform mass of tenuous gas by a process which I designated "gravitational instability." I calculated first that if all the matter in the present stars were uniformly spread out in space, it would form a gas of density about 10^{-23}. A dynamical investigation next showed that such a medium would be unstable, and that, as a consequence of this instability, it would break up, much as a jet of water breaks into drops, into condensations whose distances apart were a matter for calculation; on making the calculation these distances were found to be about equal to the actual average distance of the stars. Thus the single supposition that the stars had been born out of a uniformly spread mass of gas explained at one stroke the facts that the stars are of approximately equal mass, that they are spaced at approximately equal distances apart, and that these distances are what they are.

Dr. Hubble now finds that the nebulæ also are of approximately equal mass, that they are spaced at approximately equal distances apart, and that these distances are about 1,800,000 light-years. It is natural to inquire whether these facts cannot be explained at one stroke by the supposition that the nebulæ themselves came to birth as condensations produced by the gravitational instability of a still earlier and more tenuous mass of uniform gas. The test of the conjecture is of course by numerical calculation.

Dr. Hubble estimates that if the matter of the nebulæ were uniformly spread through space, it would form a medium of density $1{\cdot}5 \times 10^{-31}$. My theoretical formulæ ("Problems of Cosmogony," p. 219) show that instability would cause such a medium to form condensations at approximately equal distances of the order of 1,000,000 light-years. This is near enough to Dr. Hubble's observed distance of 1,800,000 light-years to make our conjecture seem reasonably probable.

If it is accepted, we have been able, with the help of the new knowledge gained by Dr. Hubble, to trace the evolution of the universe one step farther back than has been done before. We have in succession:

1. A uniform tenuous gas of density 10^{-31} and of diameter at least hundreds of millions of light-years.
2. Condensations developing in this gas at about a million light-years apart, and forming separate nebulæ with masses of the order of a thousand million suns.
3. Condensations developing in turn in the arms of these nebulæ, and forming stars with masses of the order of our sun.

To these, if my 'Tidal Theory' of the origin of the solar system (Memoirs, R.A.S., 1917) is accepted. may be added:

4. Condensations developing in the arms of gas pulled out from the stars by the tidal action of other passing stars, and forming bodies of planetary mass.

5. Condensations similarly developing in the arms of gas pulled out tidally from the planets, and forming bodies of mass comparable with the satellites of the planets.

This scheme covers five complete generations of astronomical bodies, having masses of the order of 10^{44} (or more), 10^{41}, 10^{34}, 10^{29}, 10^{25} gm. respectively, the birth of each generation from the preceding generation being through the agency of "gravitational instability" (*Phil. Trans.*, 199, A (1902), p. 49). It is based on *verae causae*, namely, the law of gravitation and the properties of the gaseous state of matter, and survives at each step the test of numerical computation and comparison.

J. H. Jeans.

Feb. 13.

Wave Mechanics and the Rotation of Homopolar Molecules.

In a letter to Nature (April 17, 1926, p. 555), J. C. Slater suggested an explanation of the 'quarter quantum numbers' used in describing the band spectra of homopolar diatomic molecules by assuming that, on the basis of the old quantum theory, the momentum was to be integrated about a half period only, since the molecule repeats itself after a rotation of 180°. This explanation finds its natural analogy in the new wave mechanics of Schrödinger, and leads to an interesting suggestion regarding the general solution of the wave equation.

In its usual form the wave mechanics presents a wave equation $(H-E)\psi=0$, where H is an operator derivable from the Hamiltonian function and E is the energy constant. It is assumed that only such solutions of the equation have a meaning for which ψ is a regular single-valued function vanishing on the boundaries.

The problem of the diatomic rotator has been solved by Schrödinger and others, who have found the following expressions for the energy and for Y where Y is that part of ψ depending solely on the space co-ordinates, in the present case upon the spherical co-ordinates θ and ϕ,

$$(1)\quad E=\frac{h^2}{8\pi^2 I}(j^2+j),\quad j=0,\ 1,\ 2,\ 3,\ \ldots$$

$$(2)\quad Y=P_{jm}(\cos\theta).(a_m\cos m\phi+b_m\sin m\phi),\qquad m=0,\ 1,\ 2,\ \ldots\ j,$$

where $P_{jm}(\cos\theta)$ is the Legendre function of the mth order.

To extend this solution to the case of a homopolar diatomic molecule, we have only to remember that by such we mean a molecule the two atoms of which are identical in mass and charge, that is, a molecule which repeats itself when it is rotated through 180°. In the wave mechanics this is clearly equivalent to the condition that only such solutions of the wave equation are to be accepted for which Y remains unchanged when $\theta\longrightarrow\pi-\theta$ and $\phi\longrightarrow\pi+\phi$. This will be the case when j is an even integer ($j=0,\ 2,\ 4,\ \ldots$), m being as before any integer odd or even.

The energy and wave function are still given by equations (1) and (2) subject only to the limitation that j shall have even integral values. It may be remarked that while we have treated the molecule as a rigid rotator, no new features are presented by taking into account the vibration of the nuclei, since such vibration does not alter the homopolar character of the system.

In applying the result just obtained to the band spectra of homopolar molecules, we notice that only bands involving a change in the electronic energy will be observed, and that if these are of the usual type possessing positive and negative branches, either the initial or the final state of the molecule must be non-homopolar. For example, if we take the excited state to be non-homopolar, we have for the energies

$$E_i=h\nu_e+hA'(j^2+j),\quad j=0,\ 1,\ 2,\ 3,\ \ldots,$$

$$E_f=hA(j^2+j),\quad j=0,\ 2,\ 4,\ 6,\ \ldots.$$

The selection rule is as usual $j\longrightarrow j\pm1$ or $j\longrightarrow j$, and the transition probabilities are given by the usual formulæ for dipole molecules. This leads to a set of band lines which correspond directly to those obtained previously by the use of quarter quantum numbers. While this is very satisfactory, a closer inspection shows that the theory is not in agreement with other features of the observed bands. Thus we should expect the zero branch to be given by the formula

$$Q_j=\nu_e-(A-A')(j^2+j),\quad j=0,\ 2,\ 4,\ \ldots,$$

whereas, for example, in the helium bands found by Curtis and Long (*Proc. Roy. Soc.*, A, 108, p. 513, 1925) the zero branch is very accurately represented by another relation, namely:

$$Q_j=\nu_e-(A-A')(j^2+j),\quad j=1,\ 3,\ 5,\ \ldots.$$

Furthermore, when j is allowed to have only even integral values, we obtain a specific heat curve which seems to be quite impossible, since the value of C_r/R rises to an abrupt maximum of about 1·5, thus giving a curve which in no way resembles the observed specific heat curve of H_2.

A way out of these difficulties may be found by employing a new postulate in the wave mechanics, namely, that, given the wave equation of Schrödinger, we shall seek such solutions to it for which the function $\psi\bar\psi$, rather than ψ alone, shall be a regular single-valued function where $\bar\psi$ is the conjugate to ψ.

This assumption, which we believe has also been suggested by Heisenberg, has much to recommend itself by being more nearly in accord with the spirit of the new mechanics, since the function $\psi\bar\psi$ seems to represent the electrical density, whereas the function ψ alone has no such physical meaning.

Applying this new assumption to the homopolar molecule, we are led to two independent solutions, the first of which is equivalent to the solution already obtained.

$$\left.\begin{array}{ll}(3) & j=0,\ 2,\ 4,\ \ldots\\(3') & j=1,\ 3,\ 5,\ \ldots\end{array}\right\},\quad E=\frac{h^2}{8\pi^2 I}(j^2+j).$$

These solutions, which are each complete in themselves and admit of no intercombination, seem to correspond respectively to the symmetrical and anti-symmetrical solutions found by Dirac and Heisenberg for systems composed of two or more identical parts.

The empirical relations found to exist among the lines of the helium bands by Curtis and Long (*l.c.*) may now be shown to be just those consistent with solution (3′), although the numerical values of the moments of inertia given by them must be increased by a factor of four.

S. Werner (*Proc. Roy. Soc.*, A, 113, p. 107, 1926) has observed recently a band spectrum of H_2 in the far ultra-violet. We find that the majority of the band lines may be arranged in P, Q, and R branches the positions of which agree with the lines derived from (3′) when we assume the final or unexcited state to be homopolar, an assumption which appears very satisfactory, since Werner's H_2 bands evidently correspond to the Lyman series of the H atom.

The band constants vary somewhat from band to band, but lead to a moment of inertia for the excited molecule of about 10×10^{-41} and for the unexcited molecule of about 6×10^{-41}. The value of the moment of inertia of the excited molecule is of the same order of magnitude as the moments of inertia found from some of the bands of H_2 in the visible region. Since the visible bands correspond to transitions in which both states of the molecule are excited, it is probable that in both states the molecule is non-homopolar, in which case we should continue to employ the usual formula for the diatomic molecule.

Equation (3′) leads to a specific heat curve for the homopolar molecule, which rises without a maximum asymptotically to the value $C_r/R = 1$. In the case of hydrogen the curve fits the experimental data rather well, although it rises somewhat too steeply in the region between 150° and 250° absolute and gives as the value of the moment of inertia of the molecule $6{\cdot}7 \times 10^{-41}$, in substantial agreement with the moment of inertia for the unexcited molecule found from Werner's bands.

We shall now give briefly the results we have obtained for other rotator systems by accepting those solutions to the wave equation for which $\psi\bar{\psi}$ is a regular single-valued function. For the simple dipole diatomic molecule two solutions present themselves:

$$\left.\begin{array}{ll} (4) & j = 0, 1, 2, 3, \ldots \\ (4') & j = \tfrac{1}{2}, \tfrac{3}{2}, \tfrac{5}{2}, \ldots \end{array}\right\}, \quad E = \frac{h^2}{8\pi^2 I}(j^2 + j).$$

As is well known, only the first solution (4) leads to a set of band lines in agreement with the observed band spectra of such molecules. A closer investigation seems to show, moreover, that (4′) has only a formal character and could only apply to molecules for which one could exclude *a priori* the possibility of their ever possessing an electronic angular momentum about the figure axis.

We have also considered the case of the symmetrical top molecule (*i.e.* a polyatomic molecule with moments of inertia $A = B$ and C) and find that the wave equation leads to two independent solutions for which $\psi\bar{\psi}$ is a regular single-valued function.

$$\left.\begin{array}{ll} (5) & \begin{cases} j = 0, 1, 2, \ldots \\ n = 0, \pm 1, \pm 2, \ldots \pm j \end{cases} \\ (5') & \begin{cases} j = \tfrac{1}{2}, \tfrac{3}{2}, \tfrac{5}{2}, \ldots \\ n = \pm\tfrac{1}{2}, \pm\tfrac{3}{2}, \pm\tfrac{5}{2}, \ldots \pm j \end{cases} \end{array}\right\},$$

$$E = \frac{h^2}{8\pi^2}\left[\frac{1}{A}(j^2 + j) + \left(\frac{1}{C} - \frac{1}{A}\right)n^2\right].$$

These solutions are each complete and allow of no intercombinations, and so far as can be seen the energy of a molecule of this type might be given by either (5) or (5′) but not in any case by a combination of the two. Equation (5) is exactly that already given by F. Reiche (*Zeit. für Phys.*, 39, p. 444, 1926) and by R. de L. Kronig and I. I. Rabi (NATURE, Dec. 4, 1926, p. 805) for the symmetrical top molecule, on the basis that the function ψ was to be regular and single-valued. On the other hand, by means of the Born-Heisenberg matrix mechanics, I have obtained two solutions to the problem which correspond exactly to the solutions given above (*Phys. Rev.*, 28, p. 318, 1926).

In the foregoing discussion of the symmetrical top molecule we have assumed that $\psi\bar{\psi}$ will remain unchanged for a rotation of the molecule of 360° about the figure axis as well as for a complete rotation about the precision axis.

If, however, the molecule has a symmetry element in the position of its particles, we must introduce further conditions. For a molecule which repeats itself after a rotation of $2\pi/k$ about the figure axis we find the two independent solutions,

$$\left.\begin{array}{ll} (6) & \begin{cases} j = 0, 1, 2, \ldots \\ n = 0, \pm k, \pm 2k, \ldots \end{cases} \\ (6') & \begin{cases} j = \tfrac{1}{2}, \tfrac{3}{2}, \tfrac{5}{2}, \ldots \\ n = \pm\dfrac{k}{2}, \pm\dfrac{3k}{2}, \pm\dfrac{5k}{2}, \ldots \end{cases} \end{array}\right\},$$

$$E = \frac{h^2}{8\pi^2}\left[\frac{1}{A}(j^2 + j) + \left(\frac{1}{C} - \frac{1}{A}\right)n^2\right]$$

where the absolute value of n is less than or equal to j in both cases.

It is with great pleasure that I thank Prof. E. Schrödinger for many suggestions and for many helpful criticisms during the course of the work. I hope to publish in the near future a more detailed paper covering the calculations.

DAVID M. DENNISON.

Zürich, Dec. 23.

Refraction of Electromagnetic Waves round the Earth's Surface.

J. A. FLEMING (*Proc. Phys. Soc. Lond.*, 26, 318-333, 1914) reached the conclusion that the variation with height of the dielectric constant of the atmosphere would bend a ray sent out tangentially to the earth's surface so that its radius of curvature would be about four times that of the earth. Furthermore, he found that, if the atmosphere were constituted wholly of krypton, a horizontal ray would have a radius of curvature equal to that of the earth, on account of its greater density.

As the radius of curvature in air is comparable with that of the earth, we thought it possible that the angle of incidence of the wave on the Heaviside layer would be so affected as to make the apparent height of the layer too great. Although we find this effect to be quite negligible, we came across a point which may be of interest—namely, if electromagnetic waves sent upwards are to return, the effective value of the dielectric constant must change with height in a definite manner.

From recent investigations it appears that from 40 km. to 150 km. above the earth's surface the temperature rises from 220° A. to 300° A. We assume that this change is linear and that the constitution of the atmosphere remains unchanged. These two assumptions, combined with the values of density and height tabulated on p. 72 of Humphreys' "Physics of the Air," give to a fair approximation the following empirical law connecting density d and height h in kilometres:

$$d = 0\,0013\, e^{-0{\cdot}14h}.$$

The well-known relation between dielectric constant K and density, that

$$(K - 1)/(K + 2) \propto d,$$

combined with the equation for d, gives the empirical relation

$$K = K_0 + \rho e^{-ah},$$

from which the value of ρ is $0{\cdot}59 \times 10^{-3}$, taking $a = 0{\cdot}14$, and $K_0 = 1$.

Considering the earth as plane, it can easily be shown that a ray starting from the earth's surface at an angle of elevation ϕ_0 will become horizontal at a height y given by

$$-ay = \log_e [(\rho \cos^2 \phi_0 - \sin^2 \phi_0)/\rho].$$

This cannot hold unless $\tan^2 \phi_0 < \rho$, whatever may be the value of α. This means, in the case of the earth, that a ray starting at an angle of elevation of more than 1°·5 cannot return to the earth if the above law for K holds. If, on the other hand, the signs of both ρ and α are changed, rays at any angle would eventually return.

The equation, when we take account of the earth's curvature, is

$$\cos\phi/\cos\phi_0 = R[1+(1-e^{-\alpha y})\rho/2]/(R+y),$$

where ϕ is the angle of elevation of the ray at any point, y the distance of the point from the surface, and R the radius of the earth.

When the ray is parallel to the earth's surface $\phi=0$. Therefore

$$\sin\phi_0 = 1 + y/R - (1-e^{-\alpha y})\rho/2.$$

From this equation conclusions can be drawn similar to those obtained above when considering the earth's surface as plane.

We thus arrive at the result that the general condition under which a ray can return from the upper atmosphere is that the second differential of the dielectric constant with regard to height should be negative. In the case of the earth's atmosphere the density, according to the assumption given above, varies in such a manner that this differential is positive. The conclusion does not hold for rays at angles of elevation of less than 1° or 2°.

J. STUART MCPETRIE.
RAYMOND M. WILMOTTE.

National Physical Laboratory,
Teddington, Middlesex,
Jan. 28.

Melanism in the Lepidoptera and its Evolutionary Significance.

IN the interesting article by Dr. J. W. Heslop Harrison in NATURE of Jan. 22 on experiments with Lepidoptera, there appears the following: "Thus we are dealing with a case of evolution directed by the environment, and presumably, therefore, of the Lamarckian order. Naturally, this view has been strongly contested by the opponents of the Lamarckian position, but, let it be emphasised, not one of those so opposed has studied the subject in the field. On the other hand, field workers are unanimous in giving it vigorous support."

I do not underrate the importance of the work of Dr. Harrison, nor do I question the accuracy of his fascinating experiments. But I must confess that I cannot understand the reference to field workers in the passage quoted. Does not the question at issue here concern the interpretation of laboratory experiments? Let us admit that in the industrial areas a tendency for certain Lepidoptera to become melanotic has been clearly demonstrated. Harrison and Garrett have shown that feeding the caterpillars with metallic salts produces the same effect, and that this induced melanism is inherited. There is, however, no evidence in the experiments that a somatic change has produced a germinal change. On the contrary, the melanotic changes did not appear in the first generation treated, but in succeeding generations. It seems just as likely, therefore, that the germ plasm has been influenced before the soma. As Harrison states near the end of his article, the experiments "demonstrate . . . that the germplasm can be influenced by external agencies." They do not supply any further evidence in support of what is usually understood by the term "Lamarckism," although their importance in other directions will be far-reaching.

W. J. DAKIN.

The University, Liverpool,
Jan. 24.

IF reference is made to my original article, it will be found that in his letter Prof. Dakin simply repeats my own views, as he himself realises when he quotes from my concluding remarks.

This position I emphasise further in a paper with the title "Experiments on the Egg-laying Instincts of the Sawfly, *Pontania salicis* Christ., and their Bearing on the Inheritance of Acquired Characters; with some Remarks on a New Principle in Evolution," which appears in the current *Proceedings of the Royal Society* (B), the 'new principle' being seen in a differentiation of that governing the melanism work from those covered by the term 'Lamarckism.' In that communication, without any possibility of misunderstanding, I state: "Clearly such evolution as is pictured at work here is not of the Lamarckian order; most likely the influences at work act directly and simultaneously on soma and germ alike, or even on germplasm alone, and, indeed, the latter view obtains concrete support from the *Selenia bilunaria* work."

However, in my opinion and in that of many other workers, if a chemical substance ingested with the food can influence the germplasm, then the germplasm can be affected through the soma. In connexion with this I ask Prof. Dakin to consider, in particular, the relation between the two existing in plants, as demonstrated in plants raised from leaf-cuttings and by other vegetative means.

J. W. HESLOP HARRISON.

Changes in the Length of the Day.

THE article by Dr. E. W. Brown on "Changes in the Length of the Day" in NATURE of Feb. 5 cannot fail to attract attention. To avoid any possible misunderstanding I think I ought to explain that the references which Dr. Brown makes to my results refer to my paper, "A Solution of Ancient Eclipses of the Sun," published in the *Monthly Notices of the Royal Astronomical Society*, Dec. 1920, not to my paper entitled "Trepidation" in *Monthly Notices* for Dec. 1926, which Dr. Brown had not seen at the time of writing. In the latter paper I show that if we adopt $4''\cdot 8$ as the change in the apparent longitude of the moon in a century, due to any acceleration not recognised in the existing gravitational theory or to changes in the length of the day, the Greenwich meridian observations give $1''\cdot 36 \pm 0''\cdot 15$ as the corresponding change in the apparent longitude of the sun, thus confirming the result which Dr. Brown cites from my work on ancient eclipses. I also find that any correction to the assumed century accumulation for the moon requires a correction of 1/9·5 as much to the deduced accumulation for the sun, so that the latter term is very little dependent on the value obtained for the lunar term.

In the same paper I show that the fluctuations to which Dr. Brown refers are found not only in the longitudes of sun, moon, and planets, but also (1) in the amplitudes of the inequalities produced by the action of Venus in the motion of the earth and of Mars, and (2) in the motion of the equinox. These results are inconsistent with the theory which attributes the fluctuations to a variation in the rate of the earth's rotation. I also find that the Greenwich meridian observations give not 1 in 13·3 as Dr. Brown has assumed, but 1 in 9·5 as the ratio between the fluctuations of the sun and moon.

It is probably too early to give a final explanation of these interesting fluctuations, but it is clear that there is a fluctuation in the total action on the earth, which determines its mean motion, amounting to between one-third and one-fourth of the fluctuation in the action of Venus, but in the opposite direction, so that an increase in the action of Venus is accompanied by a diminution in the total action, and vice versa. This seems to imply something like an interchange of mass between the sun and Venus and perhaps between the sun and other planets. In other words, I think Dr. Brown was right when in 1914 ("Report of the British Association," pp. 319-21) he attributed the fluctuations to a surge spreading through the solar system, and I think he has too readily adopted the theories of others who have tried to explain them as changes in the length of the day.

On this subject I have expressed the conclusion: "We may therefore declare with confidence that while the earth's rotation may be affected by a secular retardation, it is certainly not affected by a fluctuation" (*Monthly Notices*, Dec. 1926, p. 163).

J. K. FOTHERINGHAM.

University Observatory, Oxford, Feb. 9.

Rotation of Dielectric Bodies in Electrostatic Fields.

THE phenomenon of rotation of dielectric-surfaced cylinders between the poles of a Wimshurst machine, described by Dr. Richardson in NATURE for Feb. 12 (p. 238), and recently demonstrated by him, does not appear to differ in any essential feature from that exhibited by the old toy "electrostatic motor," consisting of several insulating spokes radiating from an axle, and each surmounted by a light celluloid or other ball. This rotated between oppositely charged knobs. The cause of rotation is presumably identical in both cases. The same result could doubtless be obtained by using a conducting surface broken up by insulating strips, as on the commutator of an ordinary D.C. motor.

CHARLES RECORD.

Technical College, Huddersfield.

Biological Fact and Theory.

I HAVE noticed that people who are good at solving cross-word puzzles are also very good at understanding those complex statements of Mendelian results. I am distressed at my inability to worry out cross-word exercises and also those F_1, F_2, etc., synoptical charts, for I feel I may be missing something that will help in an understanding of genetical problems. It would be comforting to know if there are other biologists who admit the same disability.

What, however, are the 'fundamentals of genetics,' and what is this 'whole discipline of biology' that is going to give us the key to the processes of development? Is breeding cats, and cocks and hens, and flies, and so on, such fundamental research? A 'gene' is, I suppose, a physico-chemical entity: at least, it *ought to be* such so long as we study development by chemical and physical methods. We know that it is something that grows, like a crystal of alum selects molecules of alum from its mother-liquor, or 'environment'—the two kinds of growth differ, of course, but let that pass. It selects materials from the nutritive environment and then it reassembles these materials in new chemical forms, but it also reassembles the chemical products in typical morphological constellations. How? This is *the* fundamental genetical problem.

Then a 'gene' has a quasi-independence even if it is 'linked.' It is interesting to see how genes retain their quasi-independent activities so as to continue to give us 'bar-eye' and 'spot' and 'plain' and 'red-eye,' for example, but still a red-eyed Drosophila is always a Drosophila, and so also with the four hundred other characters which presumably express the activities of as many genes. All the time we are looking at the morphological entity that we call Drosophila and 'bar-eye,' or 'red-eye,' or whatever it be, is always related to nervous system and muscles and wings and so on in a typical manner. Can there be a 'super-gene'; in other words, what is the physico-chemical mechanism that results in the development of Drosophila? This, I take it, is really what is fundamental to a knowledge of the developmental process. The appearances in the cell nucleus do not help us much, for no one now takes the crude view that the parts of the chromosomes *are* the genes. It is difficult to see how we shall advance along these lines by "building on the ample foundation already obtained by tens of thousands of breeding tests."

JAS. JOHNSTONE.

The University, Liverpool.

Illinium.

IN a copy of *Gaz. Chim. Ital.* (56, 862; 1926) received a few days ago, Prof. Rolla, of Florence, claims priority for the discovery of element No. 61, and proposes for it the name Florentium on the basis of a "Plico Suggellato" filed in June 1924. Prof. Rolla began his search for the element early in 1922 (see *Z. anorg. allgem. Chem.*, 157, 571; 1926). In making his claim for priority he was, apparently, not aware of the following facts:

In 1919 the University of Illinois and the U.S. Bureau of Standards entered on a joint investigation of the arc spectra of rare earth elements, using materials resulting from long-continued fractionations carried out at the University of Illinois. The results of this investigation were published in the U.S. Bureau of Standards Scientific Papers, 421 (1921), 442 (1922), 466 (1923). In the second of these papers, published at about the time that Prof. Rolla began his work and two years before his "Plico Suggellato" was deposited, Dr. Kiess, who carried out the spectrometric studies, reported 130 spectral lines which were common to the spectra of neodymium and samarium, in the samples submitted to him by Prof. Hopkins, and says, "These lines are of unknown origin and may belong to the missing element of order No. 61, coming between neodymium and samarium."

In January 1924, again five months before the deposit of Prof. Rolla's document, L. F. Yntema published an article, "Observations on Rare Earths. XV. A Search for Element 61," in which he gives five additional lines in the ultra-violet region, and repeats the statement that these probably belong to Element No. 61 (see *J. Amer. Chem. Soc.*, 46, 37; 1924). Finally, on the basis of still further work, including the finding of two X-ray lines of the *L* series, J. A. Harris with B. S. Hopkins announced the discovery of element 61 and proposed the name Illinium (see *J. Amer. Chem. Soc.*, 48, 1594; 1926).

In the light of these facts it would seem that the honour for the discovery of No. 61 belongs primarily to Prof. Hopkins, and that the element should be called Illinium rather than Florentium. This does not detract from the credit which Prof. Rolla should receive for his independent discovery of the element. Both Prof. Rolla and Prof. Hopkins realise that a large amount of additional work must be done before the element can be fully accepted.

W. A. NOYES.

Urbana, Ill., Jan. 29.

ERRATUM.—We regret that the inscription appearing below Fig. 1 in Prof. John Percival's letter in our issue of Feb. 19, p. 280, was incorrectly printed. It should read: "Grains of wheat found in a vase on the site of a Sumerian house (3500 B.C.). Below are two rows: the upper row of the Sumerian grain, the lower of modern grains of Rivet wheat (*T. turgidum*) for comparison. (Natural size.)"

The Dinosaurs of Tendaguru.

By F. W. H. MIGEOD.

THE expedition sent out by the British Museum in 1924 to Tanganyika Territory to explore the dinosaur remains at Tendaguru broke down in the following year on the death of Mr. W. E. Cutler, the leader, in August 1925.

I was appointed leader in his place, and work was resumed on my arrival in November of the same year. Although the rainy season was coming on I decided to begin at once, and was glad to find that the rains were not heavy enough to be a serious impediment. Occasionally a digging might be flooded if the possibility of drainage was not very good; in which case it had to be baled out. I reckon that in this region continuous work all the year round is possible, and when I left to return to England in November last, I made arrangements for the digging to be continued in my absence. This naturally ensures a much bigger output in the twelve months.

FIG. 1.—Excavating a small dinosaur at Tendaguru.

Nevertheless, prospecting is limited to the dry season. One has only to walk about the country in the neighbourhood of Tendaguru hill after the grass is burnt to see how vast is this graveyard of dinosaurs. There is an area of perhaps three miles width east and west and ten miles north and south where they may be found. Denudation in the course of ages has removed the many strata of rock that ages piled up on their remains immediately after their extinction; and once again these bones lie close to the surface. Most of the damage to them has been done in quite recent years through the penetration of the roots of plants and trees. At the present day they lie at an average level of 700 ft. above the sea, and fragments on the surface commonly, though by no means always, give an indication of where bones may be dug for. Yet further, the stratum is not always an indication, for the dinosaurs I collected lay in several different kinds of ground, as in clays of more than one kind, some stratified and some much contorted, in loose sand and in harder sand rock.

Exploration in the twelve months under review was made in thirteen different sites round Tendaguru hill, and the yield of fairly complete dinosaurs was considerable. There is possibly enough material partly to reconstruct some two dozen skeletons representing a considerable number of different species, and work has been begun on them in the Natural History Museum at South Kensington.

Some of the specimens are naturally more interesting than others. My first dinosaur excavated was a small one (Fig. 1), but near it lay the skeleton of another which eventually required eighty carriers to take it down to the port of Lindi for final packing and shipment. This one when examined may prove to be a brontosaurus. As an indication of its size I may mention that the scapulæ were 48 inches long by 28 inches at the widest part. The greater part of the body had lain on a bank, but a small stream of the distant age, of course, when that dinosaur lived and died, flowed by and had disturbed the remains on one side, some of the bones showing strongly the destructive action of this water. The pelvis, dorsal vertebræ, and upper-limb bones were mostly clear of this stream, though at no great height above it; but mixed with the lower bones were numerous river-worn pebbles, and in the case of one rib two smooth pebbles were tightly jammed under it, causing it to bend and of course break, which could only have taken place after the flesh was decomposed.

Another skeleton, that of a slender animal perhaps forty feet long, was interesting from the fact that the tail when excavated lay out on the ground complete. It was fifteen feet in length, and near the body it had been pressed down into the mud some two feet deep. It had not been completely severed, but two vertebræ nearest the pelvis were hanging vertically, there were two or three at the bottom, and one or two nearly vertical again, the upper one joining the unbroken part of the tail. It was as if at death, or shortly after, some other huge dinosaur had set its foot on the tail in passing and pressed that part of it down into the mud. The dimensions of some of the bones of this dinosaur were: femur 51 inches, scapula 44½ inches, humerus 33 inches. The fore part of the body was on a slightly lower level than the hind part and tail, and the head and neck, which were displaced, were in such a position as if it had died in drinking or trying to drink water. The body lay generally on a very dark-brown clay which I found nowhere else, and a feature, unique so far as my own excavations were concerned, was that, enclosing the bones, was a green matrix which did not exist apart from the bones (Fig. 3).

Of the sites which I worked two were cuttings into hillsides, and accordingly progress was slower here than on the flat. The hillside excavation that was especially interesting in its results was the one which I made into the side of Tendaguru hill itself. This hill stands on the top of the deposits, and represents a piece of old land left rising up like an island, and undenuded comparatively. By getting well into the lower slopes I hoped to reach bones that had not been attacked by the roots of plants and trees. Two strata of bones revealed themselves here. The upper, in the greenish-grey clay, held some bones of large size belonging to a four-footed dinosaur with the fore limbs longer than the hind ones apparently, and which was possibly a brachiosaurus. A femur in excellent preservation measured 67 inches and weighed nearly 4 cwt. when plastered and ready for removal (Fig. 2). A humerus measured 60 inches with the ends incomplete. This grey stratum rested on another of sand, and here, at the meeting of the two strata, other bones, of an apparently different type of dinosaur, were found. On this lower level and near these latter bones lay a tree trunk 26 feet long, with peat adhering, and other finds on this lower level were numerous bi-valve shells of small size, and traces of lignite, as well as impressions of leaves.

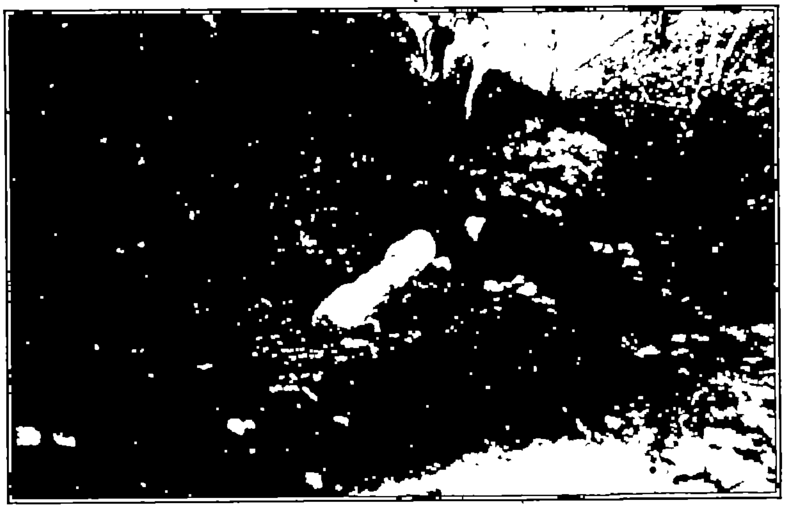

FIG. 2.—A femur 67 in. long, plastered and ready for removal.

FIG. 1.—Tail of a dinosaur in the foreground.

One of my sites furnished, in a space of 88 feet by 64 feet, a vast accumulation of bones which may prove to represent as many as twenty dinosaurs; and beyond these limits there were indications of many more. There was here what had the appearance almost of a battle-ground. We may figure to ourselves a region suffering a process of desiccation such as is going on in lands bordering on the southern Sahara at the present day, and coming on again in the Tendaguru region too. All living things flocked to the remaining pools of water for vegetation to eat and such water to drink as was left in the bed of a dried-up river; and they perished miserably one on the top of the other. A subsequent good rainy season could not help them as all was over. Sand swept over them and covered their remains, and the brief annual flow of the river in later years buried them in mud and sand. Here, as a matter of fact, there was very little clay. The deposit was principally sand, varying from a hardish yellow sandstone to loose and clean white sand.

Though this site did not furnish any bones of outstanding size, the biggest femur being 55 inches and biggest humerus 40 inches, it was interesting to find bones of quite young dinosaurs, one pair of femora measuring only 14 inches.

The position of the bones inclines one to the opinion that the dinosaurs here did not all lay themselves down to die in peace. There was much trampling by reptiles weighing several tons on others already dying or dead, which would cause some breakage of bones. There were bones which seemed to show breakage at or immediately after death, and while the muscles were still operative, one being a femur. Other bones, too, seemed to show fractures made during lifetime which healed without being set. The difference between these fractures and the clean ones made after fossilisation and due to earth tremors or stresses or to the recent action of vegetation, are readily apparent.

The dinosaur field of Tendaguru is by no means yet worked out. One might almost say it has only been scratched. That future work will yield many duplicates of the species already found is only to be expected, but it would be a serious scientific loss to the world if the area were exploited on lines of only taking certain bones and abandoning all others to perish from exposure simply because no immediate use can be made of the output. To cover up the bones again is not the same thing as leaving them untouched. In the circumstances, in view of the already considerable output, the preparation of which will take the British Museum some years, future field work at Tendaguru will be of a limited nature, and be carried on only in places where there is reason to believe in a possibility of different species being found.

Interionic Forces in a Completely Dissociated Electrolyte.[1]

By H. HARTLEY, C.B.E., F.R.S.

ONE aspect of the solution problem which has lately come into prominence is the effect of the forces acting between electrically charged ions. Faraday was much impressed by what he called "the enormous electric power of each particle or atom of matter," that is, the large size of the ionic charge. Helmholtz in his Faraday Lecture gave a calculation showing that the attractive force between the electrical charges associated with equivalent quantities of oxygen and hydrogen is 71,000 billion times greater than the gravitational attraction between these masses. It would seem obvious that such forces as these must affect the behaviour of ions. However, the difficulties in the way of a mathematical analysis of the effects of the electrical forces between ions in solution were considerable, and the problem was not attacked successfully until thirty years later.

Sutherland in 1907 was the first to suggest that electrolytes were completely ionised at all concentrations and that the interionic forces were in part responsible for the change in equivalent conductivity with concentration. In 1909, Bjerrum found that the molecular colour of chromium solutions was independent of dilution in the absence of complex ions, and explained his results on the basis of complete dissociation. He pointed out that the old difficulty with regard to the Mass Law would be removed if the interionic forces were entirely responsible for the variation of the equivalent conductivity and of the molecular freezing-point depression with dilution, as there would be no question of any equilibrium between ions and molecules.

The theory was supported by the additive properties of solutions of electrolytes and by the small change in the heat of neutralisation of strong acids and bases with dilution. In 1912, Milner succeeded in calculating the freezing-point depression of an electrolyte at different concentrations on the assumption of complete dissociation, by taking into account the change in potential energy of the ions on dilution. He pointed out that as a result of the electrical forces between them they would be so distributed that on an average unlike ions would be closer together than like ions, and that consequently work must be done in separating them on dilution. His results showed that in dilute solutions the change in the freezing-point depression with dilution could be ascribed entirely to the effect of interionic forces with a completely dissociated electrolyte.

In 1922, Debye and Hückel attacked the problem by fresh methods, starting from the same assumption of complete dissociation. By taking into account the unequal distribution of the ions, they were able to calculate approximately the freezing-point depression of salts of different valency types in very dilute aqueous solutions, although the calculated and observed values diverged at higher concentrations. But a matter of more immediate interest to us is their treatment of the conductivity problem on the basis of complete dissociation. They start from the same point of view as that of Milner, namely, that owing to the electrical forces between the ions there will be an excess of ions of opposite charge in the immediate neighbourhood of any single ion, as in the structure of a crystal of sodium chloride. Owing to the finite time which is necessary for the redistribution of the ions to take place round an ion that is in motion, there will always be an excess of ions of opposite sign in its rear, and hence it will be subject to a retardation when moving in an electric field. Further, as ions of opposite sign are moving in opposite directions and as both are supposed to carry with them a certain amount of solvent, the viscous resistance to the motion of the ions will be greater than if the solvent were at rest. Thus both these effects act in such a way as to reduce the speed of the ions. Assuming that at infinite dilution the ionic mobilities obey Stokes's equation, Debye and Hückel arrive at the expression

$$\frac{\lambda_0 - \lambda_v}{\lambda_0} = \left(\frac{K_1}{D^{\frac{3}{2}}} w_1 + \frac{K_2}{D^{\frac{1}{2}}} w_2 b\right)\sqrt{\nu m},$$

where the term $\frac{K_1}{D^{\frac{3}{2}}} w_1$ represents the fall in conductivity due to the electrical retardation and $\frac{K_2}{D^{\frac{1}{2}}} w_2 b$ that due to the electrophoresis of the solvent.

K_1 and K_2 are universal constants for all solvents at the same temperature.
D is the dielectric constant of the solvent.
w_1 and w_2 are valency factors.
b is the average radius of the ions.
ν is the number of ions per molecule.
m is the molecular concentration of electrolyte.

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[1] Extract from the presidential address on "The Ionic Theory of Electrolytic Solutions," delivered at Oxford to the Science Masters' Association on Jan. 4.

Values of w_1 and w_2 for different salt types in which the anion and cation have equal mobilities are given in the following table. w_1 varies with the relative mobilities of the two ions; w_2 is independent of them.

VALUES OF VALENCY FACTORS.

Salt Type.	w_1.	w_2.
KCl . . .	1	1
K_2SO_4 . . .	4·24	1·41
$MgSO_4$ . . .	8	2

It will be seen that the above equation is in general agreement with the experimental results for strong electrolytes, as the fall in λ is proportional to the square root of the concentration, and is dependent on the dielectric constant of the solvent and on the valencies of the ions. The best test of the theory is to see how nearly the equation enables us to calculate the conductivity of a salt in different solvents. The observed and calculated results for potassium iodide are plotted in Fig. 1, the values of b required being calculated by means of Stokes's equation from the mobilities of the ions at infinite dilution. In water and methyl alcohol the calculated slope of the λ_c/λ_0 curve is greater than the observed slope; in ethyl alcohol and acetone the agreement is very close. The salt was chosen at random; others would have given better agreement in some solvents and worse in others, but looking at the results generally, it is a striking achievement that Debye and Hückel's theory is able to predict so closely the variation of the equivalent conductivity in dilute solutions in different solvents from a knowledge of the physical properties of the solvent and the mobilities of the two ions at infinite dilution.

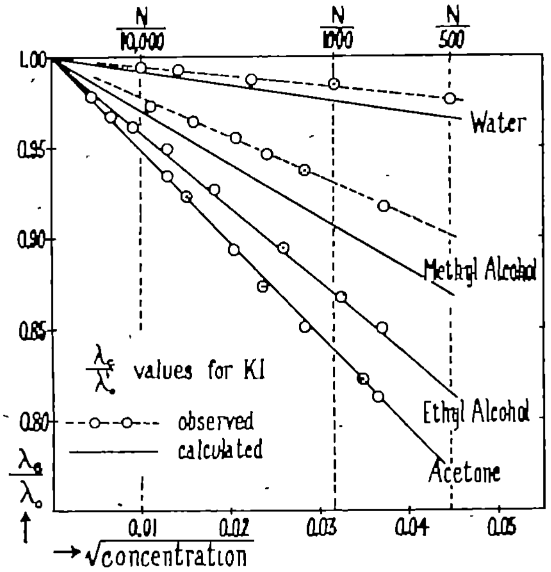

Fig. 1.

The mathematical theory is not yet in a final form even for dilute solutions; it takes no account of the changes in the solvent due to the high pressures produced locally by the electrical attractions between the ions, or of the change in the dielectric constant with the concentration of electrolyte. There is, too, some uncertainty as to the exactness with which Stokes's equation is obeyed; nevertheless, in its present form it gives us ample support for the belief that strong electrolytes are completely dissociated in dilute solution, and that the interionic forces may be responsible for their changes in properties with dilution.

Even, however, in dilute salt solutions, specific chemical interaction between the ions may be of importance, in addition to the normal electrical attraction between them. It is true that in dilute aqueous solutions there is a surprisingly close agreement between the behaviour of salts of the same valency type, although the salts of mercury form a striking exception to the rest, but when we pass to non-aqueous solvents with a lower dielectric constant, the purely physical aspect of the ionic relationship becomes more limited in its application, while the specific interaction of the ions begins to play a more important part. For example, in water the slopes of the equivalent conductivity curves of uni-univalent salts are nearly the same, while in methyl alcohol the results are far less regular; most nitrates have a different slope from that of the chlorides, and the values for silver nitrate fall much more rapidly than those for any other salt.

These differences are too great to be accounted for, on Debye's theory, by differences in the sizes or relative mobilities of the ions; and they indicate in some cases incomplete dissociation owing to interaction between the ions. With divalent ions the discrepancies in non-aqueous solvents are still more marked. In methyl alcohol, calcium chloride and perchlorate are normal in slope while calcium nitrate behaves like a weak electrolyte; with zinc, on the other hand, the perchlorate and nitrate are normal while the chloride is abnormal. Whether this is due to the formation of complex ions or of molecules is not yet known, but it is evident that in dilute non-aqueous solutions the specific interactions of the ions—in fact, their chemical affinities—may dominate the situation.

Obituary.

Sir George Greenhill, F.R.S.

The death of Sir George Greenhill will be greatly regretted by some generations of Artillery officers who were instructed by him in the mathematics of their profession as they passed through the 'Advanced Class' of the school at Woolwich which has had several names but is now known as the Artillery College. When the present writer joined that class in the spring of 1880, Greenhill had already been the mathematical professor there for several years. He went there after a short service at Coopers Hill and followed in succession Bashforth, Hirst, and Niven.

Good judges have been of opinion that Greenhill excelled in the application of dynamics to the problems of everyday life. The questions which, during many years, he contributed to test the candidates for the Mathematical Tripos and other examinations at Cambridge give ample evidence of this. They were concerned largely with the motion of trains and ships, and were recognised as being more in correspondence with actual facts on the engineering side than the academic type of question that had been previously in vogue. He was thus, clearly, the right man in the right place at Woolwich. He was able to treat artillery problems from the engineering point of view and to inspire his pupils to get as far as possible down to the actual facts of gunnery.

During the whole time that Greenhill was at Woolwich, more than thirty years, he was engaged in original investigations both pure and applied. In pure, he had a great liking for the elliptic functions, based on admiration of the classical works of Abel and Jacobi. His best work here had to do with the difficult subject of complex multiplication. In this and in similar investigations he was never satisfied with *theoretical* solutions. Abel having shown that certain equations could always be solved in radicals, Greenhill laboured actually to exhibit such solutions, and in this he was very successful. This was promptly recognised abroad, and his papers on the subject were translated into foreign languages. He was also concerned with the importance of having tables of theta-functions calculated. One of his last acts was to inspire Col. Hippisley, R.E., to carry out this work, which had been in abeyance since the death of Henry Stephen Smith.

Greenhill's leaning towards numerical results from complicated equations was assisted by uncommon algebraical power, which is constantly in evidence in his long series of papers in the *Proceedings of the London Mathematical Society*. The only book that he wrote that was entirely on pure mathematics was his " Differential and Integral Calculus " (1885). In this he is content to obtain results that are necessary for the practical applications. He had no liking for the modern refinements which are based upon the theory of functions. He was wont to speak of these as being " the morbid pathology " of the subject. He was aware, no doubt, that this " morbid " work had to be done by some one, but he was frankly out for practical applications, and was content to be in the company of many of the mathematical physicists of the day who, for example, use Taylor's theorem in practical questions and have little sympathy with a series of lectures on the cases in which Taylor's theorem fails.

Greenhill's " Applications of Elliptic Functions " is a work which exhibits many new results and much algebraical facility in getting out actual numbers. The " Hydrostatics " (1894) is probably his best book, as it is distinctly a new departure. Before its appearance the text-books were mostly on familiar academic lines and treated hydrostatic machines from a diagrammatic point of view. Greenhill's work deals, on the other hand, with the machines actually in use. He spared no pains to get down to reality. The *Transactions* of various institutions of naval architects were ransacked to supply him with problems old and new and their practical solutions. This material is arranged, described, illustrated, and treated by a consummate master of the subject. The result is a book which is unique and of exceptional value to all those who look for information on practical hydrostatics and pneumatics. It has met, it is believed, with universal approval.

Although he drew much of the material for this book from the work of others, Greenhill himself made considerable contributions to the subject. He wrote the article on hydromechanics for the " Encyclopædia Britannica." He defines it as the science of the mechanics of water and fluids in general, including fluids both in equilibrium and in motion. He made several contributions to the publications of the Institution of Naval Architects. In one of these (*Trans.*, 1894) he gave a remarkable demonstration of the theorem of Leclert which expresses the radius of curvature of the curve of flotation of a ship in terms of the radius of the curve of buoyancy, the volume of displacement, and the moment of inertia of the water-plane. It is accompanied by geometrical theorems, of much elegance, connected with stability. In another paper (*Trans.*, 1888), he writes upon the action of the marine propeller. Rankine (1865) assumed that the propeller impresses change of motion upon the water without change of pressure except such as is caused by the rotation of the race. Greenhill takes the converse view and assumes that it is obtained by change of pressure, the only changes of motion being the circumferential velocity due to the rotation of the screw, and a sufficient sternward momentum to equalise the radial and axial pressures.

Greenhill's most important contribution to practical gunnery appears to have been in regard to the rifling of ordnance. The first rifled gun-barrels came from the hands of two Nuremberg men, Kottee (1520) and Danner (1552). There exists at the Rotunda, Woolwich, a muzzle-loading barrel, dated 1547, rifled with six fine grooves. Robins, Copley medallist in 1746 of the Royal Society, experimented with rifled guns and elongated shot in England, but the question did not come seriously to the front until after the Crimean War, when the increased muzzle-velocities and the high pressures in the powder chambers and barrels caused the subject to be urgent. Armstrong's firm, and in particular Capt. (afterwards Sir Andrew) Noble, was the pioneer, and by proposing an increasing twist in the rifling from the powder chamber to the muzzle, directed the attention of the world of science to the problem. Greenhill worked at the subject independently. He established that the pitch of the rifling necessary to keep a projectile in steady motion is independent of the muzzle-velocity, of the calibre, and of the length of the gun ; depending principally on the length of the shell and on its description, so that, for similar projectiles, one pitch would do for all guns. The importance of this work and its value to Great Britain are beyond all question.

In gunnery Greenhill, at Woolwich, did much to mprove the application of the results of Bashforth's experimental work. In external ballistics he did not do anything comparable with the pioneer work of the latter, who laid a foundation stone which, through the years, has never been appreciably disturbed by the workers in any country of the globe.

The War, which disclosed many new problems, found Greenhill in retirement. The questions came before other brains and hands, and enormous progress has been made in every branch. The last occasion upon which he was much in evidence was during the meeting of the British Association and of the International Mathematical Congress at Toronto in 1924. On the passage out in the *Coronia* he was observed to be suffering and failing generally. He was a pathetic sight as he moved slowly about the boat. It will be remembered that he could not be found when the company arrived at Montreal. In answer to a telephone call he was not reported at Toronto, and real anxiety at once existed as to what had befallen him. This lasted for several days until it was discovered that he had really gone on straight to Toronto without telling any one of his intention and without reporting his arrival in that city officially. He was one of the few men of science at the meeting who had accompanied the Association in 1884 when it met at Montreal, for the first time in Canada, under the presidency of the late Lord Rayleigh. He had in his possession a photograph of a group of men taken on that occasion, on the outward voyage. It caused much interest, as it put in evidence the antiquated appearance that a group taken forty years ago can exhibit.

Greenhill was always somewhat eccentric, and as he became older increasingly so. Many of his colleagues or pupils who have travelled with him will recall that he was prone just to catch his train, so that he frequently just missed it. This, of course, is not an eccentricity which works well for the fellow traveller. In the earlier years he was distinctly sociable, certainly so at Woolwich. Later he became less so, and other points in his character—such, for example, as not giving a direct answer to a question—were accentuated. These peculiarities of thought and mind, which were constantly in evidence in social circles, appear to some extent in his mathematical writings and letters; also particularly in the reviews for which he was responsible in Nature and other periodicals. He was obsessed by the idea that mathematicians were not sufficiently engineers and were too much addicted to the philosophical side of their subject. Scientific engineers have been apt to regard him as being unpractical. Undoubtedly he stood somewhere between mathematicians and engineers, and was probably more of a mathematician and less of an engineer than the late Prof. Perry.

Greenhill's mathematical ability was recognised throughout his life. He was second wrangler in 1870, Pendlebury's year, and was bracketed with the latter for the Smith's Prize. He became a fellow of the Royal Society in 1888 and served in the Council in 1896. He received its Royal medal and also the de Morgan medal of the London Mathematical Society. He was corresponding member of the Paris Academy of Sciences and Officier d'Académie, and a foreign member of the R. Accad. Lincei. Young men who evinced a liking for mathematical research always received encouragement from him when he came across them. This was particularly so when it was a case of one who had not been through the usual scientific 'mill.' By such he is gratefully remembered. P. A. M.

Dr. C. D. Walcott.

Geologists and palæontologists mourn the loss of Dr. Charles Doolittle Walcott, who died on Feb. 8. For the last half-century he had occupied a foremost place in research in North America, and his discoveries in the older Palæozoic rocks had excited universal interest and admiration. At an age when most workers begin to need some repose, he continued his investigations with unabated vigour, and he was active in the pursuit of science almost to the end.

Charles D. Walcott was born in New York Mills, Oneida County, New York State, on Mar. 31, 1850, and was descended from New England settlers who had emigrated from Shropshire in the seventeenth century. When still at school at Utica he had already developed an interest in science, and at the age of thirteen he began to collect systematically both fossils and minerals. From school he proceeded to the Utica Academy, and eventually started life as clerk in a hardware store, where he acquired a practical business training which he always felt had been a real advantage in his later career. At the same time all his spare energies were devoted to scientific studies, and his discovery of Cambrian and Ordovician fossils near his home caused him to resolve that he would spend his life so far as possible in investigating the oldest fossiliferous rocks of the North American continent. In 1871, when visiting Indianapolis, he was encouraged in this resolve by Prof. E. T. Cox, who was at that time making a geological survey of the Indiana coalfields. Walcott therefore abandoned commerce, and spent the next five years on a farm at Trenton Falls, where he arranged to do a certain amount of manual labour in return for his board and lodging, and kept the rest of his time for study and field-work. In 1873 he sold his Trenton fossils to the Museum of Comparative Zoology, Harvard University, and would at the same time have gone to pursue a course of study under Prof. Louis Agassiz, had not that great naturalist just died. He had already discussed his plans for future research with Agassiz, and had decided that one of his main endeavours should be to determine the nature of the trilobites. He began by making polished sections of specimens from the Trenton Limestone, and thus discovered the first evidence of the branchial apparatus and the limbs in this group of fossils.

At last, in November 1876, Walcott found a congenial official appointment which enabled him to start his life's work in earnest. He became assistant to Prof. James Hall, the well-known State Geologist of New York. For three years he continued his researches while discharging the routine duties of this position, and in 1879 he entered a still wider field as assistant in the United States Geological Survey, which was then directed by Clarence King at Washington. He began his new official work by studying the geology of the high plateau of southern Utah and the country so far as the bottom of the Grand Canyon of Colorado. He then joined Arnold Hague in the survey of the Eureka mining district in Nevada, and in investigating the Palæozoic rocks of central Nevada. In 1882 he added to his other duties the identification in the Museum at Washington of all the Palæozoic fossils collected by the Survey; but he still continued his special studies of the Cambrian and earlier fossiliferous formations. After several promotions, he became director of the United States Geological Survey in 1894, and retained this appointment until he was elected secretary of the Smithsonian Institution in 1907. His business aptitude enabled him to reorganise the Survey and associated services on a more satisfactory basis than before, and he so gained the confidence of Congress that the appropriations for scientific work were much increased. For ten years from 1897 Walcott also acted as assistant secretary of the Smithsonian Institution in charge of the National Museum, and from 1902 until 1905 he was chief administrative officer of the newly founded Carnegie Institution of Washington.

Administrative duties never appeared to reduce Walcott's powers of research, and during the whole of his career he published in rapid succession papers and memoirs especially on the early Palæozoic fossils, which were always important—often startling—additions to knowledge. His works on the Cambrian faunas of North America and China are noteworthy as showing how varied was the life of the earliest geological period of which we have any satisfactory knowledge, and they will always remain classic. His discoveries of fossils in the still earlier Algonkian rocks of North America are pioneer contributions to a subject on which palæontologists eagerly await more information. His recognition of fish-remains in the Ordovician rocks of Colorado, at first received with scepticism, has now been confirmed by similar discoveries in other parts of North America.

Walcott was especially successful in finding impressions of soft-bodied organisms in the Algonkian and Cambrian formations—organisms which theoretically must have existed in immense variety before the habit was acquired of secreting hard parts which were capable of preservation as ordinary fossils. So long ago as 1898 he published a memoir on peculiar structures from the Middle Cambrian of Alabama which he regarded as the imprints of medusæ. In 1914 he described other structures from the Algonkian rocks of Montana which he interpreted as representing a very varied assortment of calcareous algæ. Almost every year after he became secretary of the Smithsonian Institution he spent the summer in studying the Cambrian formations of the Rocky Mountains in British Columbia; and in the Burgess shale of Mount Stephen he made a great collection of exquisite impressions of soft-bodied animals, previously unknown, which he described as primitive crustaceans, holothurians, annelids, and medusæ. There are still differences of opinion as to the success with which Walcott interpreted these several remarkable discoveries; but all are agreed that they add immensely to our means of studying the dawn of life on the earth, and make us hopeful of eventually finding at least some really generalised ancestors of several of the groups of invertebrate animals.

Walcott was especially fortunate in his home life, and both his first wife and the present Mrs. Walcott were ever sympathetic and helpful in his work. His unwearied industry was sustained until his last illness, and the joy of research always sufficed as recreation and relaxation from the arduous duties of administration.

Walcott naturally received many honours both at home and abroad. He was president of the National Academy of Sciences from 1917 until 1923, and received the Hayden medal from the Philadelphia Academy of Sciences. He was a foreign member of the Geological Society of London, and was awarded the Bigsby and Wollaston medals by that Society. He was also a corresponding member of the Royal Geographical Society. On his last visit to England in 1909 he received the degree of Sc.D. from the University of Cambridge. He was a corresponding member of the Academy of Sciences, Paris, and was awarded the Gaudry medal by the Geological Society of France. He was also a corresponding member of many other societies and academies on the European continent. The value of his work was indeed widely acknowledged by his contemporaries, and his researches will always be appreciated as remarkable pioneer efforts to understand some of the earliest phases of the geological record. A. S. W.

WE regret to announce the following deaths:

Mr. Francis Campbell Bayard, president in 1898–99 of the Royal Meteorological Society. At his home at Wallington, Surrey, he equipped a meteorological station and maintained regular observations there from about 1890 until last year. He died on Jan. 22, at the age of seventy-five years.

Dr. F. H. Knowlton, geologist on the United States Geological Survey since 1907, known chiefly for his work on the fossil flora of North America, on Nov. 22 aged sixty-six years.

Lieut.-Col. Henry Mellish, president of the Royal Meteorological Society in 1909–10. He maintained a climatological station at his home at Hodsock Priory, Notts., and had an unbroken series of observations for the past fifty years. He died on Feb. 2, at the age of seventy years, immediately after taking the morning observations.

Miss Matilda Smith, associate of the Linnean Society, who contributed many drawings to the *Botanical Magazine*, to Hooker's "Icones Plantarum," and to other works, and was associated for more than forty years with the Royal Botanic Gardens, Kew.

News and Views.

During the past few days, considerable prominence has been given in the Press to the appeal issued by the National Union of Scientific Workers to all men and women in Great Britain qualified in science to state their views on the possibility and desirability of building up a body which can claim to be fully representative of their varied interests. They are not asked to join the existing organisation, although they are being given an opportunity of stating if they believe that around the existing nucleus such a body can be built up. The appeal is issued over the signatures of eminent scientific workers, leaders in industry, and public men of differing political views. In addition to the principal signatories, a hundred men and women, representative of every branch of science and nearly every scientific institution in Great Britain, are giving their support to the movement. Such support should go far to remove some of the prejudices which have arisen against this body, mainly due to the title which was chosen by its founders. The words "National Union" are sufficient to arouse in some minds the fear that members of such a body must necessarily contemplate the ultimate use of the strike weapon in enforcing their demands. It is well, therefore, that it is definitely stated in the appeal that recourse to this method of redressing the grievances of scientific workers would be ineffective and absurd. What the society does hope to do, however, if it becomes fully representative, is to mould public opinion to bring about a greater appreciation of potentialities of science and thereby create a greater demand for scientific services, and also to instil the knowledge that this demand can only be met adequately by making the conditions of service sufficiently attractive to bring to the pursuit of science the highest intellectual types in Great Britain. Above all, it aims at producing in scientific workers themselves a consciousness of their functions as citizens, to the end that they will endeavour to take a more active part in the control and the direction of the affairs of a type of civilisation for the evolution of which science is chiefly responsible.

Lord Balfour received a deputation on Feb. 16, representative of various societies and authorities interested in the pollution of the rivers and estuaries of Great Britain, which urged the appointment of a central committee with power to co-ordinate the investigations and efforts now being made to cope with this problem. The need for legislation from the aspect of water-supply, inland and esturine fisheries, public health, and the amenities of the countryside was indicated, and a memorandum by a joint committee of the British Waterworks Association and the Salmon and Trout Association submitted. Lord Balfour acknowledged the very complete way in which the deputation presented its case. He pointed out that the central authority would require executive powers to reserve and purify waters and override other conflicting interests. He stated that co-ordination and advice alone would, in his opinion prove insufficient; what is wanted is more knowledge of the various pollutions. With each manufacture producing its own particular type of evil, each requires its own separate remedy, which can only be found by research. The Government is prepared to supply financial resources so that these necessary investigations may be carried out. The need for more knowledge to provide a firm basis for adequate and equitable legislation was emphasised in our leading article of Jan. 1. This is clearly the view now held by the Government. Compared with the issues at stake, the cost of research is minute, and it is the only practicable insurance against wasteful expenditure in attempts to cope with the purification of noxious effluents.

H.M. the King has signified his intention of visiting Cardiff during Easter week, accompanied by H.M. the Queen, to open the National Museum of Wales. This will be the fulfilment of a hope expressed by His Majesty when he laid the foundation-stone of the Museum in 1912, that he would be able to open the building then inaugurated. The building which will be formally opened by the King includes the magnificent south front, containing the great domed central hall, and a series of galleries on the east and west sides, erected at a cost of a quarter of a million pounds. It represents but part of the complete scheme. The recent donation of £35,000 by Lord Buckland will enable the council of the Museum to proceed with the erection of a further series of galleries on the eastern side, and it is estimated that the building, when completed, will have cost not far short of a million pounds. The interest which the King and Queen have maintained in the progress of the institution, culminating in their visit for its formal opening, should go far in emphasising to the people of Wales the importance of their national Museum and in stimulating their support to enable the full scheme to be brought to fruition.

At the meeting of the Royal Astronomical Society in June of last year, the president, Dr. J. H. Jeans, offered to endow an annual lectureship. This was gratefully accepted, and following the wish of the donor, it was called the George Darwin Lectureship. The deed of gift allows considerable latitude in the time of delivery of the lecture and in the choice of the lecturer, although it was suggested that the lecturer should preferably be resident outside the British Isles, and that the gold medallist of the year might often be a suitable lecturer. This year the Gold Medal of the Society was awarded to Prof. Frank Schlesinger, Director of the Yale University Observatory, and at the annual general meeting of the Society on Feb. 11, the president gave the usual address on the award of the medal. Prof. Schlesinger was prevented by illness from attending the meeting, but he has now arrived in England and will give the first George Darwin Lecture at the next meeting of the Society on Mar. 11, when also the Gold Medal will be presented to him. The title of his lecture will be "Astronomical Photography of Precision."

After a consideration of the quantum theory, Prof. A. S. Eddington, in his fifth Gifford Lecture in the University of Edinburgh on Feb. 18, said it is now generally accepted that in the reconstruction of ideas required to remove the present discrepancy between classical and quantum laws, the quantum laws must form the basis. These grade into the classical laws when the quantum numbers are very large; and it is only then that the classical conception of the physical world—including space, time, electrons, force, etc.—has any application or meaning. In this reconstruction all the determinism is removed from the laws of physics; the apparent determinism is found to be merely high probability. The probability is high (amounting practically to certainty) when averages of large numbers are considered; but in individual processes only moderate odds are concerned. The new quantum mechanics contains only laws which decide the odds; it apparently has no cognisance of any factors deciding what actually will happen. In the old conflict between free will and predestination, it has hitherto seemed that physics comes down heavily on the side of predestination. The quantum theory has entirely removed this bias. Whatever view we may take of free will on philosophical grounds, we cannot appeal to physics against it. The latest picture of the atom contains no mark or factor to decide what *that* atom will do next (although it contains factors deciding the average conduct of a number of such atoms); and whilst further developments in the theory may possibly disclose such a mark, it is on the whole rather against the spirit of the modern conception to expect this.

In his sixth Gifford Lecture, delivered on Monday, Feb. 21, Prof. Eddington dealt with the nature of the stars. He pointed out that failure of the perfect gas laws begins when the atoms are so closely packed that they begin to jam against one another. Generally this begins when the density approaches that of the liquid state; but that refers to terrestrial atoms fully arrayed with their systems of electrons. In estimating the congestion at the very high temperature in the stellar 'ball-room,' we must remember that 'crinolines' of electrons are no longer worn. Thus the stellar ions will not begin to jam until a much higher density is reached, and stellar material can still be a true gas even when its density is that of water or of platinum. Evidently it is possible for stellar matter to reach a density transcending all terrestrial experience. This conclusion recalls a strange message contained in our observations of the faint 'Companion of Sirius,' which was previously dismissed as incredible. Apparently this star had a mass nearly equal to the sun's mass packed into a globe not very much larger than the earth. Fortunately it has been possible to test this conclusion by a method based on Einstein's theory of gravitation, and Prof. W. S. Adams, at the Mount Wilson Observatory, has confirmed this huge density. It is 60,000 times the density of water, and a ton of the material could be contained in a match-box. It is not a new chemical element; it is ordinary matter under extraordinary conditions, namely, with the atoms so shattered by high temperature that they can be packed into an extremely small compass.

A Lecture on "Conceptions of the Cosmos from the Times of Copernicus to Galileo" was delivered at Bedford College for Women (University of London) by Sir Frank W. Dyson, the Astronomer Royal, on Feb. 15. Before the sixteenth century the earth, moon, and sun were accepted as globes, the size and distance of the moon from the earth had been roughly calculated, but the theory of epicycles was still used to explain the movements of the stars in a geocentric cosmos. Copernicus (1473–1543), using Ptolemy's records, thought out a heliocentric system. His cosmos was a series of concentric circles, of which the fifth was the orbit of the earth, with the epicycle of its satellite, the moon. He added an unnecessary 'third movement' of the earth to account for its axis pointing always to the same region of the heavens. Tycho Brahe (1546–1601), though a careful observer, refused to accept the Copernican cosmos and imagined a heliocentric grouping of the planets, but a geocentric cosmos; the moon's and the sun's orbits turned about the earth as a centre, but the movements of the heliocentric planet group formed an epicycle. Kepler (1571–1630) rejected Tycho Brahe's theory and completed the Copernican system, founding his theories upon the incomparable observations of Tycho Brahe. He studied the orbit of Mars and established three laws, which include the principle that the orbits of the planets are not circles, but ellipses with the sun as a focus. His work was not immediately accepted. Galileo (1564–1642) developed the use of the telescope and thus discovered a larger number of stars and the nature of the surface of the moon. His main discovery was that of Jan. 7–14, 1610, when he observed the movements of the satellites of Jupiter and thus produced another argument in favour of the Copernican system. By the work of these four men the geocentric conception of Ptolemy was thus replaced by the heliocentric system now accepted.

Mr. F. J. W. Whipple, the Superintendent of Kew Observatory, sends us a description of a remarkable deposit of rime observed by him in Arundel Park and the neighbourhood on Saturday, Feb. 12. It will be remembered that the south of England was covered with fog for several days. The fog was exceptionally thick on the South Downs on Friday, Feb. 11. When Mr. Whipple made his observations on the Saturday morning it was misty. The rime in many places was heavy enough to bend the tree branches. In the light breeze the fragments of rime blown from the trees pelted the passer-by in no pleasant fashion. In places the fallen rime lay on the ground to the depth of an inch. Rime on the ground had not the brilliance of fresh snow: it made a rather dirty grey. From a distance the grey patches under the trees and bushes were more conspicuous than the unfallen rime. There was, of course, rime on the grass. The deposit on the wiry grass stalks was curious, however, in that very frequently it changed sides half-way up. The deposit on the lower half of the stalk pointed into the wind (the N.E. wind which prevailed when the rime was formed on the trees), but on the upper half the deposit was on the lee side. Another unusual phenomenon was the occurrence of pieces of ice embedded in an earth bank. Each of these pieces of ice was encrusted on a fragment of chalk. A chalk fragment about two inches square and half an inch thick might carry a lump of ice or rather a brittle crown of ice about an inch high. There was no ice on the soft earth or on the roadway nearby. The phenomenon occurred close to trees with a very liberal deposit of rime.

At the anniversary meeting of the Geological Society on Feb. 18, the awards already announced in our columns (Jan. 29, p. 169) were presented by the President, Dr. F. A. Bather. On behalf of Sir Albert Kitson, the Right Hon. W. Ormsby Gore received the Lyell Medal, and the balance of the Murchison Fund was handed to Sir Arthur Smith Woodward for transmission to Dr. Haughton. Alluding to a revival of interest in systematic concepts, in which palæontologists have played a large part, Dr. Bather then discussed the present position and possible future of "Biological Classification." Distinguishing the practical aim from the philosophical, the artificial system from the scientific, he showed the relation of the Key to the former and discussed the stages and various basic ideas of the latter. The phylogenetic mode of approach, and particularly palæontology, have made changes necessary. The phylogenetic method was contrasted with the morphological; the ways of breaking up a phylogenetic tree were discussed, and the concepts of the grade, the genus, the lineage, the gens, the seriation, and the species were expounded. Convergence and polyphyly affect genera and species no less than higher groups. The ordinary species (Linneon) is composed of elementary species (Jordanons); but the true *infima species* of a phylogenetic classification carried to its logical end would be the gene. If, then, a thoroughgoing phylogenetic system is impracticable, might it not be equally scientific to have an adaptational classification? Perhaps this would be more useful and more illuminating; but equally impracticable. Many of our present difficulties arise because the phylogenists have been hampered by a system built on a different plan. In Dr. Bather's opinion the only salvation lies in a compromise accepting the practical intention of binomial nomenclature, and producing a system sufficiently flexible for use by morphologist, ethologist, phylogenist, and stratigraphical geologist.

The Frazer Lecture in Anthropology for 1927 will be delivered at Cambridge on Mar. 2, the lecturer for this occasion being Dr. R. R. Marett. It will be remembered that this lecture is on a foundation formed a few years ago from a fund raised as a tribute to the work in anthropology of Sir James G. Frazer. It is delivered in rotation in the universities with which Sir James Frazer has been connected—Cambridge, Oxford, Liverpool, and Glasgow. Among those who have previously lectured on the foundation are the Rev. J. Roscoe, Dr. E. S. Hartland, and Dr. B. Malinowski. Sir James and Lady Frazer will entertain a number of friends to dinner in Trinity College on Mar. 1, most of whom will remain in Cambridge for the Frazer Lecture on the following day.

The well-known seismic district along the Dalmatian coast has lately been visited by violent earthquakes, the first and strongest at 4.19 A.M. on Feb. 14, and a second, also of destructive intensity, at about 2 P.M. on Feb. 16. Though the loss of life seems to have been small, the area of damage was of great size. Along the coast, it extends from Sebenico on the north to Trebinye on the south, towns which are about 150 miles apart; inland, it reaches beyond Mostar, which is about 40 miles from the coast. Several recent earthquakes in this district, such as the Sinj earthquake of July 2, 1898, have been traced to important dislocations; though, on the whole, the exact positions of the epicentres are not well known. The recent earthquake appears to have been connected with a long fault, roughly parallel to the coast, and possibly a short distance to the west.

Michael Faraday was born in Southwark, London, and his father's forge stood near the well-known "Elephant and Castle" of that place. The Southwark Borough Council desires to commemorate the association of this great pioneer of science with the borough by forming a special collection of standard and current literature on electrical and allied sciences in the Central Reference Library, and by placing in the library a bust of Faraday. It is proposed also to create a Faraday Memorial Library Fund, the income from which would be used to keep the library supplied with the best books upon these subjects. Both object and aim are worthy and appropriate, and we are glad to commend these to readers of Nature. Any contributions in support of this memorial in Faraday's native borough should be sent to the Town Hall, Walworth Road, London, S.E.17, and be addressed to the Mayor of Southwark.

An appeal of exceptional interest is issued by the Gravesend Borough Library and the Gravesend and District Scientific and Archæological Association with the object of raising funds towards the reconstruction of Milton Chantry for the purpose of a museum and library of local history. The Chantry, which is the oldest building in Gravesend and one of the most picturesque in the neighbourhood, dates, at latest, from the early fourteenth century, and is of the greatest importance to archæologists, and also, be it said, to the general public from the historical point of view. Much of the original timber of the roof remains. The walls of flint and chalk are mostly three feet thick and have been preserved by a casing of brick erected in Elizabethan or Jacobean times. The total amount required for reconstruction is £2500, of which £550 has already been contributed by the Office of Works and £500 by the Corporation of Gravesend. The latter body has also voted £400 per annum for upkeep in conjunction with the existing Borough Library. The scientific and educational value of a well-organised and well-arranged local museum needs no emphasis. But the importance of Gravesend as a centre of archæological and historical research, rich in prehistoric, early British, Roman, and Anglo-Saxon remains, already well represented in the collections in the custody of the Library Committee, render this appeal, which has the support of such bodies as the Society of Antiquaries, the Royal Anthropological Institute, and the Royal Historical Society, a matter of national and not merely of local interest.

The January issue of the *Quest* contains an interesting article by Prof. D. Fraser Harris on "Science and Preconceived Perfection," in which he gives numerous examples from the history of natural science and medicine of attempts to hinder the progress of science by religious doctrines or other preconceptions. One of the earliest examples of this was the opposition which Galileo encountered for his description of the spots on the sun, owing to the preconceived notion of his opponents that the sun was perfect. A similar preconceived idea of perfection led Hoffmann of Nuremberg to attack Harvey's discovery of the circulation, a constant return of blood to the heart being regarded by Hoffmann as an imperfect arrangement. Throughout the Middle Ages the progress of anatomy was checked by the Mohammedan injunction against dissection on the ground that touching a dead body rendered a man ceremonially unclean. The Italian surgeon Tagliacozzi, who introduced a plastic operation for repair of the nose, ears, and lips in the middle of the sixteenth century, was denounced for his impiety in daring to alter the human countenance, and after death his bones were scattered by order of the ecclesiastical authorities. In more modern times, the opposition to inoculation against small-pox, of which Voltaire was so ardent a propagandist, and later to vaccination and the use of chloroform in childbirth, was partly based on the belief that such methods were interfering with the will of Providence.

In continuation of the excellent series of exhibits dealing with modern scientific research which have recently been on view at the Science Museum, South Kensington, an exhibition has been arranged under the auspices of the British Research Association for the Woollen and Worsted Industries, which will be opened on Mar. 1 by the Earl of Balfour. Dr. F. A. E. Crew, Director of the Animal Breeding Research Department of the University of Edinburgh, is co-operating with the Association and has arranged a biological section designed to show the application of science to the wool industry in all its stages from the sheep to the finished fabric. In this section will be illustrated questions of breeding, feeding, and fleeces. The exhibits will be divided into groups showing research on wool characteristics and processes, technical research, dyes and wool, worsted spinning, woollen carding and spinning physical research. It should be noted that a number of the exhibits have been supplied by the firms connected with the Association. The Woollen Industries Research Association was incorporated in 1918 and has its own chemical, physical, and engineering laboratories at Torridon, Headingley, Leeds, with more than thirty trained investigators. Its annual budget is about £14,000. The fundamental work of the Association deals with pure research on wool and the processes involved, with the view of increasing the quality and quantity of the fibre, improving and cheapening manufacture, and enhancing the appearance and prolonging the life of the finished fabric.

At the invitation of the American Association of Economic Entomologists and the Entomological Society of America, the fourth International Congress of Entomology will be held at Ithaca, New York, presumably in the third week of August 1928. A preliminary programme will be issued in the near future.

At the annual general meeting of the Quekett Microscopical Club on Tuesday, Feb. 8, the following officers were elected: *President*, Dr. W. T. Calman; *Vice-Presidents*, Sir David Prain, Mr. D. J. Scourfield, Mr. J. M. Offord, Mr. C. D. Soar; *Hon. Treasurer*, Mr. F. J. Perks; *Hon. Secretary*, Mr. W. S. Warton; *Hon. Reporter*, Mr. A. Morley Jones; *Hon. Librarian*, Mr. C. S. Todd; *Hon. Curator*, Mr. C. J. Sidwell; *Hon. Editor*, Mr. W. S. Warton.

At the anniversary meeting of the Geological Society of London held on Feb. 18, the following officers were elected:—*President*, Dr. F. A. Bather; *Vice-Presidents*, Dr. J. W. Evans, Prof. E. J. Garwood, Dr. E. Greenly, Mr. H. W. Monckton; *Secretaries*, Mr. W. Campbell Smith and Dr. J. A. Douglas; *Foreign Secretary*, Prof. J. E. Marr; *Treasurer*, Mr. R. S. Herries; *New Members of Council*, Dr. E. E. L. Dixon, Dr. J. D. Falconer, Prof. V. C. Illing, Mr. Philip Lake, and Prof. H. H. Swinnerton.

At the annual general meeting of the Physical Society, held on Feb. 11, the following officers were elected:—*President*, Prof. O. W. Richardson; *Vice-Presidents other than Past Presidents*, Dr. E. H. Rayner, Prof. E. A. Owen, Dr. D. Owen, and Prof. F. L. Hopwood; *Secretaries*, Prof. A. O. Rankine, Imperial College of Science and Technology, and Mr. J. Guild, National Physical Laboratory, Teddington, Middlesex; *Foreign Secretary*, Sir Arthur Schuster; *Treasurer*, Mr. R. S. Whipple; *Librarian*, Mr. J. H. Brinkworth; *New Members of Council*, Mr. T. Smith, Prof. E. N. da C. Andrade, and Dr. Ezer Griffiths.

The Principal Trustees of the British Museum have appointed Dr. W. D. Lang, Assistant Keeper in the Department of Geology, to a Deputy Keepership in the same Department. Dr. Lang was educated at Christ's Hospital, Harrow School, and Pembroke College, Cambridge. He obtained a first class in Part I of the Natural Sciences Tripos in 1901 and his research work gained him the Sc.D. degree in 1919. He entered the service of the Trustees in 1902 as assistant in the Department of Geology. His chief publications have been on fossil Polyzoa, fossil corals, recent insects, philosophical biology, and the geology of the neighbourhood of Charmouth, Dorset.

The Dyers' Research Medal, offered each year by the Worshipful Company of Dyers for the best scientific research or technical investigation connected with the tinctorial arts which has been submitted to the Society of Dyers and Colourists for publication in its journal, has been awarded for 1925–1926 to Dr. H. H. Hodgson, for work carried out in the Department of Colour Chemistry at the Technical College, Huddersfield. Dr. Hodgson has had two papers in the Society's journal during this period: (1) "Behaviour of the Sulphides of Sodium in Aqueous and Alcoholic Media" (July 1925), and (2) "The Action of Sulphur on the Monochloroanilines" (Mar. 1926). During the year 1926, sixteen papers have been published in various scientific journals by Dr. Hodgson and his research students.

We are informed by Messrs. Carl Zeiss (London), Ltd., that a contract has just been signed for the purchase of a Zeiss planetarium for the city of Vienna. The opening date has been fixed for May.

The January number of *Watson's Microscope Record* (No. 10) contains a practical paper on "Critical Illumination," by Dr. F. J. Brislee; chapter 2 of "The Desmidiaceæ," by Mr. G. T. Harris; and a paper on "Relief Staining of Bacteria, Protozoa, Infusoria," by Dr. A. C. Coles, in which the use of a saturated aqueous solution of nigrosin is advocated as giving apparently permanent preparations showing minute characters and structure not otherwise seen. The *Record* is published three times a year, and will be forwarded free on application to Messrs. Watson and Sons, 313 High Holborn, W.C.1.

Applications are invited for the following appointments, on or before the dates mentioned:—A lecturer on public health at the Westminster Hospital School of Medicine—The Dean, Westminster Hospital Medical School, 12 Caxton Street, S.W.1 (Mar. 1). An assistant master at the Redhill Junior Technical School and Technical Institute to teach mathematics, with mechanics as a subsidiary subject—The Secretary, Education Committee, Municipal Buildings, Reigate (Mar. 2). A research bacteriologist at the Low Temperature Research Station, Cambridge—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1 (Mar. 11). A junior assistant at the Building Research Station, Garston, Watford—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1 (Mar. 11). An assistant lecturer in agriculture under the County of Southampton Education Committee—The Director of Education, The Castle, Winchester (Mar. 11). An assistant in the statistical department of the Rothamsted Experimental Station—The Secretary, Rothamsted Experimental Station, Harpenden (Mar. 17). An instructor in engineering science at the Kingston-upon-Thames Technical Institute—The Principal. A teacher of engineering subjects at a junior technical school of the Wandsworth Technical Institute—The Principal. A graduate for engineering subjects and mathematics at the Workington County Technical and Secondary School—The Principal. A senior laboratory assistant in the department of Pathology and Bacteriology of the University of Sheffield—The Professor of Pathology, The University, Sheffield. A part-time demonstrator of biology at St. Thomas's Hospital Medical School—The Medical Secretary, St. Thomas's Hospital Medical School, S.E.1. A junior physicist under the Linen Industry Research Association—The Secretary, Research Institute, Lambeg, Co. Antrim.

Our Astronomical Column.

A Fixed Easter.—Mr. J. J. Withers, University of Cambridge, has introduced a bill in the House of Commons proposing to fix Easter as the Sunday following the second Saturday in April, and thus reduce its possible range from five weeks to one week. The matter has been before a special committee of the League of Nations for the last year or two, on which there were representatives of the principal religious bodies, and it was agreed that no insuperable obstacle lies in the way, if there is sufficient consensus of public opinion in favour of the change. The subject was dealt with in an article in our issue of Nov. 27, 1926. It is likely that the present bill is intended merely to strengthen the hands of the League of Nations committee; if so, there is nothing to be said against it. But it would be undesirable to give it legal effect before obtaining general ecclesiastical sanction.

There are millions of people in Great Britain and Ireland who would not admit the power of a secular legislature to fix the date of a religious festival; the public holiday, of course, lies within its competence, but to divorce this from the feast with which it has always been associated would meet with serious opposition.

Spectroscopic Parallaxes.—Two papers on the spectroscopic parallaxes of stars are published in the current number of the *Astrophysical Journal* (vol. 64, No. 4). The first, by Adams, Joy, and Humason, gives the parallaxes of 410 M-type stars based on recent research into the behaviour of suitable lines in spectra of this type. The list includes all the Boss stars north of −30° declination, together with about 100 dwarf stars of faint visual magnitude; many stars classed as $K5$ at Harvard are also included. For the giant M-type stars the lines used were at λλ4207, 4258, 4389, 4489 (Fe); λ4077 (Sr$^+$); $H\gamma$, and $H\beta$. The reduction curves were based, primarily, on mean parallaxes from parallactic and peculiar motions; these results being corrected by a method of successive approximations. For the dwarf stars the lines found to be most suitable were λλ4318, 4435, 4454, 4586 (Ca); λ4535 (Ti blend); and λ4607 (Sr). The reduction curves were based entirely on trigonometric parallaxes. The results show an interval of more than six magnitudes between the faintest giants and the brightest dwarfs, within which there is an entire absence of stars. The rapid variation in luminosity with spectral type for the dwarf M-type stars also suggests the possibility of obtaining parallaxes from this relation alone.

The second paper, by A. V. Douglas, is on A-type stars. Two methods of attack were used. The first, depending on the variation in relative intensities of arc and spark lines, resembled that devised by Adams for later type spectra. The pairs of lines found by Douglas to show the necessary variations were: λλ4215 : 4227, 4233 : 4227, 4535 : 4481, and 4549 : 4481. In the second method a relation was discovered between luminosity and the width of the lines λ4481, $H\delta$, and $[K]$, so that seven criteria were finally available for determining parallaxes. The reduction curves were based on a combination of group with trigonometrical parallaxes, and were determined separately for stars of sharp- and diffuse spectral lines. The final results are given in a list of parallaxes of 200 A-type stars.

Research Items.

Malayo-Polynesians in America.—Dr. Paul Rivet again attacks the question of the migrations of Malayo-Polynesians to America in vol. 18, No. 5, of the *Journal de la Société des Américanistes de Paris*. He briefly reviews the evidence of physical anthropology and ethnography with which he has dealt previously. The form of certain types of skull in lower California shows a Melanesian affinity, while the Lagoa-Santa skull is of a type of wide distribution in South America and presents affinities with the hypsistenocephalic type of Melanesia and Australia. In the material culture a large number of objects of typical Polynesian or Melanesian character, of which a detailed list is given, are also found in America. The linguistic evidence—a detailed examination of grammatical structure and comparison of vocabularies—shows a close affinity between the Hoka family which extends, though not continuously, from Oregon to Salvador, and the Malayo-Polynesian family. If we accept Uhle's classification and dating of pre-Inca pottery in Peru, and put the first wave of immigration as contemporary with the proto-Nasca ware, this would give a date at about the beginning of our era, but Uhle's dates are too low and allow an inadequate period for the evolution of the stone age in America. These immigrants met and were to a great extent overwhelmed by the migrations of peoples from Asia who were responsible in the main for the general physical character of the American Indian; but it would be a mistake to regard the part played by the Malayo-Polynesian element in the racial make-up of America as negligible.

Individual Difference in Accident Rates.—The problem of accidents is still challenging attention. Some time ago a report by Miss E. M. Newbold was reviewed in this journal: in this report a statistical study of the human factor in the causation of accidents was made, and it appeared that, quite apart from the objective causes of accidents, there was a personal factor operating that rendered some people more liable than others to accidents. Since then the problem has been studied from another point of view by E. Farmer and E. G. Chambers, and their findings are published by the Industrial Fatigue Research Board in Report No. 38 (London: H.M.S.O. 2*s*. 6*d*. net). The writers tested workers in various occupations for æstheto-kinetic co-ordination, intelligence, and nervous instability. The results of these tests were correlated with the accident records of the same subjects. While the authors draw but tentative conclusions from a very interesting piece of work, yet, however tentatively expressed, the results are valuable. It appears that it can be definitely asserted that inequality in accident liability is not solely determined by external factors or by chance, but is due to measurable individual differences. A relationship can be shown to exist between accidents and poor æstheto-kinetic co-ordination, but there is no relationship between accidents and the higher intellectual processes. These results afford confirmation of the earlier work as well as adding fresh knowledge. It is perhaps not going too far to hope that the time will come when it will be possible to estimate an individual's accident liability with mathematical accuracy.

Ultramicroscopic Organisms as Symbionts.—In an article entitled "Ultramicroscopic Life," published in the Nov. issue of the *Rivista di Fisica, Matematica e Scienze Naturali* (Naples), Prof. Umberto Pierantoni gives an account of those ultramicroscopic organisms which are used by higher organisms as factors of their normal functions. These so-called ultramicrosymbionts occur at least as frequently as the microsymbionts, and the functioning of organs and tissues by means of such protoplasmic inclusions must be regarded as a normal phenomenon and not as analogous to pathogenic ultramicrobic symbiosis, which constitutes an abnormality of only a few individuals of a species. The penetration of ultramicrosymbionts into the egg of an insect may immediately determine a change in the direction of embryonal morphogenesis leading to the formation of new organs. Investigations on luminous animals have demonstrated that the presence of such ultramicro-organisms in many animals, especially cephalopods, is accompanied by the appearance of highly complicated structures — lenses, reflectors, refractors, analysers of light—due to stimuli exerted by them in the cells in which they become located. The effects which these organisms exert on the cell plasma undoubtedly tend to modify and regulate the activity, and indeed to determine the specific activity, of the plasma. Bioluminescence, with the many indisputable cases in which it is due to symbiosis, has entered a new field of study, and, if it could be proved that luminous ultramicrosymbionts exist, the phenomenon would admit of a definite explanation.

Life-History and Distribution of Limnæa.—Dr. C. L. Walton and W. Norman Jones (*Parasitology*, 18, No. 2, 1926) report the results of observations in North Wales on the life-history of *Limnæa truncatula*, the usual intermediate host of the liver-fluke of the sheep. The average number of eggs in 20 egg-masses of this snail, collected in March 1925, was 9·75, and the hatching period (in the laboratory) was 12–26 days, with an average of 20–21 days for the spring generation. The young snails were isolated and reared, and they deposited eggs during the first week of July, which hatched in the first week of August. *L. truncatula* is therefore self-fertile. Data were obtained which show that two and probably three generations occur between March and October. Dr. Walton and W. Rees Wright (*op. cit.*, No. 4, 1926) find that, in North Wales, *L. truncatula* occurs over a range of pH 6·0 to 8·6, *L. peregra* pH 5·8 to 8·8, and *L. palustris* pH 7·4 to 8·0 (three readings only), and they express the opinion that the hydrogen-ion concentration is not of vital importance to these snails or, on the evidence available, to mosquito larvæ. The differential distribution of *truncatula* and *peregra*—for these species are seldom found together though they may be abundant in contiguous environments and some overlapping may occur—is accounted for by the relatively broader foot and shell of *peregra*, which enables it to travel over the surface of soft mud in which *truncatula* would sink.

Forestry Research in South Africa.—The Research Station of the Forest Department of South Africa, situated at Deepwalls, Knysna, has made remarkable progress and carried out some important investigation work during the comparatively few years which have elapsed since its inauguration on up-to-date lines. One of the troublesome factors in connexion with forestry work in the Dominion is the restricted area and size of the indigenous forest. The department is seeking to rectify Nature's deficiencies in this respect by the artificial cultivation of conifers, with the view of the gradual reduction of imports of soft woods and the saving of expenditure in this direction. The opinion is held by a section of forest officers that in every country efforts should be made to safeguard the future of, and even extend when necessary, the indigenous forests; that a total reliance on forests of exotic species is, economically, a mistake. Those holding such views will be interested in the paper by Mr. John Phillips, of the Deepwalls Research Station (*Ecology*, vol. 7, No. 3, July 1926), dealing with the biology of the flowers, fruits, and young regeneration of *Olinia cymosa* Thunb. This is one of the South African forest trees and is known as 'hard pear.' The tree plays an important part in forest succession in the Knysna forest region, and also produces a most excellent timber for constructional purposes. Little has been known of the power of reproduction or facilities for propagation either of this or other important species of these curious indigenous forests. By his close study into the habits of *Olinia cymosa*, Mr. Phillips discloses an extraordinary state of affairs which, if equally true of other species, furnishes a reason for the poor condition of growth of the forests. In spite of an extravagant production of flowers and fruits season by season, by one individual or another, the production of fertile seeds is small, and only a very few natural seedlings actually result from a heavy crop of flowers. The problem of how to assist and increase the natural regeneration of the species is dealt with in some detail, as also the main factors, which require further elucidation.

Russian Exploration in Mongolia.—Expeditions of the Russian Academy of Sciences were working in Mongolia in 1925 and 1926, studying mainly soils, vegetation, and partly also the fauna of the country. The so-called Gobi 'Desert' has been crossed twice, and this enabled the expedition to state that the whole north-western part of Gobi does not represent a desert, but is a flat steppe, with brown soil with some pebbles, and populated by nomad Mongolians; there occur locally some low ridges and stationary sand-hills; underground waters are everywhere near the surface and the grass cover was generally good. In remarkable contrast with the present steppe landscape of the Central Gobi are groups of large trees (elms) which apparently mark some old valleys now filled in. A special party of the expedition was occupied in detailed studies of local soils, and special attention has been paid to the study of processes of origin and accumulation of soluble salts in the soils.

Volcanic Rocks of Central America.—In the *Journal of Geology* for Nov.-Dec. 1926, P. C. Putnam describes the petrography of the lavas of Central America. In an arcuate zone concave to the Pacific, vulcanism began in the late Cretaceous and Eocene, languished during the succeeding period when folding and intrusion were going on, and broke out afresh with explosive fury in the Miocene. The lava basements of the present volcanoes are thought to be of Pliocene age, while the cones themselves are of later age and have been built mainly of ejectamenta with only occasional lava-flows. Throughout this region half a dozen rock types are widely distributed, both in space and time, ranging from olivine-basalt through latite to rhyolitic pumice. Partial analyses show that all the types are simply related, the most characteristic feature of the province being the richness of the basalts in potash and the complementary abundance of soda at the rhyolite end of the series. This feature suggests that the basalts are not representatives of the layer which gives rise to plateau-basalts, but are rather differentiation products of an intermediate latite magma. The weighted silica percentage is 62, and that of other circum-Pacific provinces ranges from 58 to 63. The explosive phase of eruptivity that followed the Oligocene intrusions gives strong support to Dr. Day's recent recognition of the importance of the gases given off during the crystallisation of an underlying cauldron, and their bearing on local volcanic phenomena.

The *Elephas antiquus* of Pignataro.—A large fossil elephant's skull, found at a depth of 8 m. at Fontanarosa, on the southern slopes of the hills commanding Pignataro Interamna, near Cassino, is described by G. De Lorenzo, *Rivista di Fisica, Matematica e Scienze Naturali* (Dec.). The old quaternary soil in which the skull was found has previously yielded fossil mammoths, but the latest find is one of importance as it represents a complete skull of enormous dimensions, measuring 3·50 m. from the frontal protuberance to the apex of the tusk. Moreover, it appears to have been found in its original, and not in a secondary, position, the animal having sunk in muddy ground and been submerged by a further deposition of alluvium. Consequently it is hoped that the whole of the remainder of the skeleton may be found, although difficulties may be expected owing to the decalcification of the bones, possibly as a result of infiltration of water charged with carbon dioxide.

Oil in Burma.—An important contribution to the petroleum geology of Burma was made by Dr. L. Dudley Stamp at the meeting of the Institution of Petroleum Technologists on Jan. 11. Since the publication of Pascoe's well-known memoir on "The Oilfields of Burma" in 1912, very little information has appeared concerning work on oilfield developments, much remaining hidden in the archives of the companies responsible for the intensive geological surveys carried out for this purpose. Oil in Burma is not confined to the Peguan beds but, according to the author, may be found at all horizons from the middle of the Eocene to the top of the Peguan (Oligo-Miocene); such petroliferous horizons are definitely associated with intermediate conditions, *i.e.* phases in the history of the Burmese gulf when neither freshwater nor deep marine environments are implied; a clear understanding of the distribution of oil in the Tertiary rocks follows from a consideration of this gulf as the recipient of river-borne sediment from the north, and marine sediment from the south, and a good case is made out for proving the fallacy of one stratigraphical oil-bearing horizon in Burma. This stressing of essential *facies* rather than essential structure in oil accumulation constitutes a principle often overlooked in other countries than Burma; structure is necessary, but without the right type of rocks being involved, its testing makes an unprofitable and discouraging task. Evidence is adduced in support of the contention that mother- and reservoir-rocks in Burma are identical, *i.e.* that vertical migration is precluded by the rapid alternation of porous sand and impervious clay; lateral migration may have been operative. "Oil is always found in strata in which the majority of fossils are marine, but of shallow water type." This statement naturally leads the author to discuss the coal-oil relationship, which he is inclined to regard as accidental, rather urging that one essential to the formation of petroleum is a concentration of salts in the water of a land-locked lagoon or lake, or on the seaward side of a delta.

Low Temperature Carbonisation.—The Department of Scientific and Industrial Research has issued a report of a test of another process for the carbonisation of coal at low temperatures, in accordance with the scheme in vogue (Nature, Sept. 20, 1924, p. 441). This report of the Director of Fuel Research deals with the 'Freeman' Multiple Retort of British Oil and Fuel Conservation, Ltd., Willesden. In this plant the coal is fed into the top of a tower built up of circular compartments separately heated by external gas burners. The coal is mechanically stirred and moved downwards from one compartment to another until it leaves as a mixture of breeze and dust, which is therefore not directly available for use as domestic fuel but might serve for powdered fuel. The striking result was the high yield of tar, 21·1 gall./ton, which is the highest yet observed with any plant tested by the Fuel Research staff. This high yield may be due to the fact that the gas is removed immediately from the plant, each compartment having an offtake. The yield of gas was low, and of ammonia negligible. Considerable mechanical trouble occurred with the plant, and it may be inferred that the process is not technically mature.

The Thermal Ionisation of Elements.—In their earlier attempts to obtain experimental evidence of the thermal ionisation of elements, the experimental arrangements of Saha and his collaborators have always been open to the criticism that the ionisation potentials of the vaporised elements were less than the potential differences actually existing between various regions in the vapour. In their latest arrangement (*Zeit. fur Physik*, vol. 40, p. 648, 1926) Saha, Sur and Mazumdar have used a vacuum oven, similar to King's design, and have heated the elements under investigation in an auxiliary oven made of quartz. The latter was kept at a temperature lower than that of the vacuum oven, and served to regulate the vapour pressure of the elements. The degree of thermal ionisation was determined by measuring the electric current between two parallel graphite plates, which were mounted on molybdenum rods insulated from the oven, when a potential difference of only 1 volt was applied to them. The temperature of the vacuum oven was measured by a Wanner pyrometer, and that of the auxiliary oven by means of a thermocouple. With this arrangement no current was recorded when mercury, zinc, or cadmium were heated up to 2000° C.; heated magnesium gave only a small current, but heated potassium and sodium gave large currents of the order of some milli-amperes. These results are in complete agreement with the magnitude of the ionisation potentials of the elements investigated.

The Fluorescence of Iodine Vapour.—It is well known that iodine vapour may be caused to fluoresce by illumination with light of suitable wave-length, and that this fluorescence is markedly decreased by the addition of foreign gases to the vapour. G. Ramsauer (*Zeit. fur Physik*, vol. 40, p. 675, 1927) has recently made experiments to determine whether this decrease depends on the wave-length of the light which produces the fluorescence. Pure iodine vapour and iodine vapour containing air were simultaneously illuminated with light from the same source, and the intensities of the fluorescent light from the two samples of vapour were compared by means of a polarisation photometer. Within the limits of experimental error no difference was found when green or yellow light was used to produce the fluorescence. The vapours were also excited by light from an arc of which the anode consisted of an alloy of sodium and cadmium, and the lines of the fluorescent spectra produced by the cadmium and sodium lines respectively were photographed and compared. There was a faint indication that the molecules of air produced a slightly greater effect on the fluorescence caused by the sodium lines than on that caused by the cadmium lines. On the quantum theory it would be expected that the intensity of all the terms of a fluorescence series would be decreased in the same proportion when molecules of a foreign gas are added to the vapour. This was proved to be untrue in the case of measurements carried out on iodine vapour containing oxygen, when the cadmium, copper, mercury, and sodium lines were used to produce the fluorescence. It is suggested that the presence of molecules of a foreign gas causes a change in the probability of transition of the excited iodine molecules.

Micro-crystals in Electrolytically Deposited Silver.—An X-ray examination of the micro-crystals in electrolytically deposited silver, carried out by H. Hirata and H. Komatsubara, is described in the *Memoirs of the Kyoto College of Science*, Series A, Nov. 1926. The X-ray photographs show that the micro-crystals of silver have a tendency to deposit in a fibrous form, and that the diagonal axis of each cubic lattice is parallel to the axis of the fibre. These results contradict those of Glocker and Bozorth, who suggest that electrolytically deposited silver has no regular orientation.

Instruments for Measuring Alternating Currents.—An interesting paper, by Lieut.-Col. K. Edgcumbe and F. E. J. Ockenden, on recent improvements in the design of measuring instruments for alternating current work, was read to the Institution of Electrical Engineers on Feb. 3. Except for radio frequency measurements, the 'hot-wire' type of instrument, once so popular on the Continent, is now 'antiquated.' For measuring electric currents and moderate voltages, the 'moving-iron' type of instrument is coming into general use. For very high voltages electrostatic instruments are employed, and for measuring power, electrodynamic instruments. Practically every scale now used subtends an angle of 120° at the pivot instead of 90° as formerly. But this merely improves the ease with which they can be read. It has little effect on their accuracy. The range of electrostatic condensers can be multiplied to any extent by putting condensers in series with them. It is now also of importance to measure the peak value of the high voltage wave so as to be able to calculate the maximum value of the electric stress on the insulating material. The simplest method of doing this is by means of a neon tube. It is known that a neon tube, if exhausted to the point of minimum impedance, breaks down at a peak voltage which is practically independent of the frequency of the supply and the temperature. The neon tube, shunted by a variable condenser, is put in series with a high-pressure air-insulated electrostatic voltmeter. The 'striking' of the neon tube can be detected in the dark by the luminous effect produced, but it can always be detected by means of a head telephone in series with the neon tube. The accuracy of hot-wire ammeters at high frequencies is sometimes questioned as the 'skin effect' comes into operation. It is stated that the error due to this cause in a good instrument when measuring 3 amp. at a frequency of 5,000,000 does not exceed 1 per cent.

Preparation of Hydrogen Peroxide.—A simple method of preparing concentrated solutions of hydrogen peroxide is described by M. L. Kilpatrick, O. M. Reiff, and F. O. Rice in the *Journal of the American Chemical Society* for Dec. 1926. A 20 per cent. solution of sulphuric acid, cooled in ice, is treated with small quantities of sodium peroxide until nearly neutralised. The crystals of sodium sulphate which form on standing are filtered off, and the adhering hydrogen peroxide washed into the filtrate. Vacuum distillation at 60°-65° yields a 20 per cent. solution which is treated with silver sulphate to remove chloride. After further distillation the solution is concentrated at room temperature over sulphuric acid in a vacuum desiccator for three days. By this means an excellent yield of approximately 90 per cent. hydrogen peroxide is obtained.

The Royal Society Election.

SELECTED CANDIDATES.

THE president and council of the Royal Society have recommended the following candidates for election as fellows of the Society :—

E. V. APPLETON, M.A., D.Sc. Wheatstone Professor of Physics in the University of London. Formerly Fellow of St. John's College, Cambridge. Distinguished for his researches on electric waves, atmospherics, and the Heaviside layer. Author of many papers upon these subjects published in the *Proceedings of the Royal Society*.

T. G. BROWN, M.D. Professor of Physiology, University College, Cardiff. Distinguished for his knowledge of physiology. Author of "Studies in the Physiology of the Nervous System" (*Quart. Jour. Exper. Physiol.*, 1909–1916), and many other papers.

R. H. BURNE, M.A. (Oxon). Curator of the Department of Comparative Anatomy, Museum of the Royal College of Surgeons. Author of many important contributions to comparative anatomy extending from 1892 until 1923, and published in the *Proceedings of the Zoological Society*, *Proceedings of the London Malacological Society*, the *Journal of the Linnean Society*, and *Journal of Anatomy and Physiology*.

J. CHADWICK, Ph.D. Fellow of Gonville and Caius College, Cambridge, and Assistant Director of Radio-Active Research in the Cavendish Laboratory. Distinguished for his researches on radio-activity and atomic structure, especially investigations on the properties of α- and β-particles and on the magnitude of the charge on the nucleus and the law of force around it. Since 1919 he has collaborated with Sir Ernest Rutherford in pioneer investigations of the disintegration of elements by α-particles which have yielded results of fundamental importance.

G. M. B. DOBSON, M.A. (Cantab. and Oxon), D.Sc. (Oxon). University Lecturer in Meteorology, Oxford. Distinguished for his work in meteorological physics. As Major in the R.F.C. was in charge of instrument research for the Air Force at Farnborough and at the Air Ministry, and designed many aircraft instruments now in use. Author of papers in the *Proc. Roy. Soc.* and other journals on conditions in the upper atmosphere, atmospheric turbulence and similar topics.

S. Z. DE FERRANTI, Hon. D.Sc. (Manch.). Electrical Engineer. Faraday Medallist of the Institution of Electrical Engineers. He has contributed in a notable degree to the advancement of electrical engineering, especially by his remarkable pioneering work in relation to the generation and distribution of energy by means of electric current at high voltages. His work on the electric furnace, on the electric energy meter, and in improving alternating current generators and motors, has been of the greatest value.

J. KENDALL, M.A. (Edin.), D.Sc. (Edin.). Professor of Chemistry, Columbia University, New York. Distinguished as an investigator in physical and general chemistry. Has published since 1912, partly with collaborators, more than sixty papers in *Proc. Roy. Soc.*, *Jour. Chem. Soc.*, *Phil. Mag.*, *Jour. Amer. Chem. Soc.*, *Jour. Phys. Chem.*, etc., dealing with the ionisation process, strong electrolytes, correlation of ionisation and solubility in solution, and related subjects.

P. P. LAIDLAW. Investigator at the National Institute for Medical Research, Hampstead. Formerly Dunn Professor of Pathology, Guy's Hospital. Distinguished as a pathologist, pharmacologist, and biochemist.

A. A. LAWSON, D.Sc., M.Sc., Ph.D. Professor of Botany, University of Sydney. Investigator of embryology of Gymnosperms (*Annals of Botany*, 1904–10, and later in Australian publications), seven memoirs; of Gametophytes of Psilotaceæ (*Trans. Roy. Soc. Edin.*, 1915–16); also of cytology (*Trans. Roy. Soc. Edin.*, vols. 47-48); an authority on algal floras of the west coast of America, Jamaica, and Britain.

J. W. MELLOR, D.Sc. Inorganic, physical and technical chemist. Director of the British Refractories Association and Principal of the Pottery School, Stoke-on-Trent; Honorary Secretary of the Ceramic Society. Distinguished as the author of "A Comprehensive Treatise on Inorganic and Theoretical Chemistry," ultimately extending to at least twelve volumes, of which six are now published—a reference work so valuable to chemists that its importance can scarcely be over-estimated. Is the leading authority on the scientific principles underlying the pottery industry, and the author of some fifty original publications on the chemistry and physics of ceramics.

OTTO ROSENHEIM. Distinguished for his investigation into the chemical nature of substances of physiological importance. His work on sphingomyelin and the galactosides of the brain is recognised to be definitive. He discovered, simultaneously with others but independently, the effect of irradiation upon cholesterol. With Dudley he has established the chemical nature of spermine and effected its synthesis.

M. SAHA, D.Sc. Professor of Physics, University of Allahabad. Especially distinguished for his development of the theory of high-temperature ionisation, which has been applied by himself and others to account for many of the principal features of solar and stellar spectra.

J. S. B. STOPFORD, M.D. Professor of Anatomy, University of Manchester. Distinguished for his investigations on the peripheral sensory nervous mechanisms, and particularly for the correlation of the results of his anatomical, experimental, and clinical observations, the one with the other, as well as with those of other workers (*Jour. Anat.*, 1918–21; *Lancet*, 1915–22; *Brain*, 1920); and for his technical achievement in determining the exact distribution of arteries in the brain, and enunciating important morphological principles and clinical applications (*Jour. Anat.*, 1916 and 1917).

H. H. THOMAS, Sc.D. (Camb.). Petrographer to H.M. Geological Survey. Harkness Scholar and Sedgwick Prizeman. Distinguished for his researches in petrology and stratigraphical geology. Author of many papers in the Geological Society publications dealing with the stratigraphy, palæontology, and petrology of South Wales, petrology of the sapphire bearing rocks of Mull and of the Triassic sediments of Devonshire; also papers on minerals and technology in the *Mineralogical Magazine*.

C. M. WENYON, M.B. B.S., B.Sc. (Lond.). Director of Research in the Tropics to the Wellcome Bureau of Scientific Research. Distinguished for his work in medical protozoology. Author of more than fifty published memoirs embodying the results of his researches on the parasitic Protozoa—especially those causing diseases in man. He has made important contributions to protozoology, and to knowledge of leishmaniasis, malaria, amœbic dysentery, and trypanosomiasis.

Birds of Ecuador.[1]

THIS is a companion volume to the "Distribution of Bird-Life in Colombia," forming vol. 36, 1917, of the *Bulletin of the American Museum*. It differs from many other valuable ornithological books in the fact that at least one-third of it is most interesting reading, and not for specialists in ornithology alone. The introductory chapters, after giving a review of the history of Ecuadorean ornithology, and describing the work done in Ecuador by the American Museum's expeditions, partially under the leadership of the author himself, describes clearly and vividly the general physiography of the country, the distribution of forests, the climatic conditions, and chiefly the life-zones. The author admits four life-zones: the tropical, the subtropical, the temperate, and the Paramo zone, which is the treeless region above 11,000 feet to the snow line.

While the avifauna of the subtropical zone must have derived from the tropical, and that of the temperate from the subtropical one, that of the Paramo, the youngest Andean zone, has acquired its bird-life comparatively recently, not from the neighbouring temperate zone of the Ecuadorean Andes, but very largely from its sea-level equivalent in Patagonia. This is fully explained by numerous examples. In comparing the various regions, numbers of genera are often used; this is not very useful, however, as the limits of genera are so differently defined by various ornithologists, the number of genera generally being greater in American works than in European, with one or two exceptions. It would be better if comparative lists of faunal regions were only given in species and subspecies.

Both books of Dr. Chapman show how wonderfully rich in species the highlands of the Andes are, in comparison with, for example, the elevated portions of Africa; thus, while on Ruwenzori only 95 'zonal' birds, as the author calls them, are known, not less than 412 are recorded from Ecuador, of which about 300 could be found within an area no larger than that occupied by Mt. Ruwenzori. This is doubtless due to the much larger extent of the highlands of the Andes as well as to their much greater height, but also, one may add, to the fact that altogether South America—even the lowlands—is richer in species than Africa. 1508 species and subspecies are included in the list of the birds of Ecuador, a larger number than has before been recorded from an area of similar size. Only 151 forms are treated trinomially as subspecies. The reason for this is that a number of forms have been admitted as species, because it is not known that they intergrade with others. This is still often done in America, but the known existence of intergradations is due to the material available in collections, and it is impossible to say if intergradations occur in the case of rarer birds, of which only a few skins are known. The method of many modern European ornithologists, who regard as subspecies all forms agreeing in the essential characters and only differing in shades of colour, size, or other details, if they strictly represent each other geographically, seems to be more natural.

Dr. Chapman is to be congratulated on his book, which is adorned by maps, photographs of scenery, and by excellent coloured plates of birds, and it is to be hoped that a volume on the birds of Peru may follow before long, so as to give us a still fuller knowledge of the birds of western South America.

University and Educational Intelligence.

CAMBRIDGE.—The following have been appointed as the Council of the School of the Physical Sciences: Mr. A. Berry, Mr. Cameron, Prof. Eddington, Mr. R. H. Fowler, Prof. Hutchinson, Prof. Inglis, Dr. H. Jeffreys, Mr. Landon, Sir Joseph Larmor, Mr. Lees, Mr. McCombie, Prof. Newall, Sir William Pope, Sir Ernest Rutherford, Prof. G. I. Taylor, Mr. L. B. Turner.

Dr. A. C. Haddon has been elected a member of the governing body of the International Institute of African Languages and Cultures. Dr. R. R. Marrett will give the Frazer lecture on Mar. 2 on the subject, "The Diffusion of Culture."

The General Board of Studies has recommended to the University that the readership in geography, about to become vacant by the resignation of Mr. Lake, should be continued.

Honorary degrees are proposed for Brigadier-General E. W. Costello, V.C., officer in command of the University contingent of the Officers' Training Corps, and for Colonel T. C. Hodson, reader in ethnology.

Three Davison scholars will be elected next term for a year's study at Harvard, Yale, and Princeton Universities. Scholars are chosen from undergraduates or bachelors of arts in residence.

THE *Faraday House Journal* for the Lent term shows that there are 83 students in their first year in the college, 51 in their second year, which is spent in mechanical engineering works, 74 in their third year, spent in college, and 71 in their fourth year, spent in electrical engineering works. The names of 45 old students who have obtained appointments since the issue of the Michaelmas number of the journal are given, with the titles of the posts obtained. There are five short scientific articles by staff and old students, amongst them one by the Principal, Dr. A. Russell, showing that the recent experiments which appear to indicate that an electric spark can pass between electrodes near together when the difference of potential between them is less than 350 volts, are probably vitiated by the electrostatic attraction between the electrodes having pulled them together. There are several scholarships and exhibitions offered by the college to be competed for in April next.

THE prefatory note to a pamphlet published by the Universities Bureau of the British Empire (50 Russell Square, London, W.C.1), entitled "Professional Schools, Post-Graduation Courses, Specialist Studies, in the Universities and University Colleges of Great Britain and Ireland, 1926–27," clearly describes its purpose: "Of their [the universities] several fields of study the greater part is common ground, yet each of them has its special plots which it cultivates. . . . The statements which follow indicate the respects in which the universities, individually, specialise, *i.e.* undertake work which is not common to them all." That the pamphlet accomplishes what it promises can best be shown if it be imagined that half-a-dozen students, unacquainted with the "special plots" of universities, desired, respectively, to attend lectures in oceanography, constitutional experiments in the Irish Free State, problems of bi-lingualism, tuberculous diseases, technical chemistry, the leather industry. Twenty minutes' study of this pamphlet would save them hours of hunting through bulky prospectuses and calendars, and would save much preliminary correspondence with registrars.

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[1] *Bulletin of the American Museum of Natural History.* Vol. 55, 1926: The Distribution of Bird-Life in Ecuador; a Contribution to a Study of the Origin of Andean Bird-Life. By Frank M. Chapman. Pp. xiv+784+30 plates. (New York: American Museum of Natural History, 1926.)

Calendar of Discovery and Invention.

February 27, 1706.—On this day John Evelyn, the diarist, died. He is commemorated here for his "Silva, a discourse of forest trees," 1664. It was Evelyn's house, Saye Court, Deptford, in which lived Peter the Great. Evelyn is also known as one of the founders of the Royal Society.

February 27, 1812.—Wilhelm von Biela, an Austrian major, on Feb. 27, 1812, discovered Biela, the comet to which his name was given. The comet had a period of 6¾ years, and when it returned in 1846 and 1852 it was seen to have divided into two comets. It then disappeared, but at the end of 1872 showers of shooting stars were observed, and it is believed these were caused by the breaking up of the comet.

February 28, 1838.—A report on Kew Gardens by Dr. John Lindley and two practical gardeners, dated Feb. 28, 1838, recommended that the gardens should be transferred to the care of the nation. They were duly taken over by the Commissioner of Woods on April 1, 1840, and W. J. Hooker was appointed director. It was under his skilful management that the gardens gained the high reputation they now enjoy.

March 1, 1866.—While a journalist in London, Walter Weldon (1832–1885) became interested in industrial chemistry, and though at first ignorant of chemical analysis, on Mar. 1, 1866, he took out the first of several patents connected with the manufacture of soda and chlorine. His introduction of the 'lime-manganese' process in the production of chlorine reduced the price of bleaching powder £6 a ton and, in the words of Dumas, cheapened "every sheet of paper and every yard of calico." The Weldon process has now been superseded by electrolytic methods.

March 2, 1617.—This is the date of the first British patent, but it was the Act of 1623 which for the first time secured "the sole working or making of any manner of new manufactures within this realm to the true and first inventor."

March 4, 1866.—On the memorial to Sir Norman Lockyer in the observatory on Salcombe Hill, Sidmouth, he is described as a "pioneer in the investigation and interpretation of the chemistry of the sun and stars and in the science of astronomical physics." It was on Mar. 4, 1866, that Lockyer first applied the spectroscope to the direct examination of the sun's surface, and in the same year he proposed a new method of observing the 'red flames' of the sun in daylight. A more powerful instrument came into his hands in October 1868, and on Oct. 20 he wrote to the Royal Society: "I have this morning perfectly succeeded in obtaining and observing part of the spectrum of a solar prominence." Janssen had achieved the same result in India, and the joint discovery was recognised by the striking of a medal by the French Government.

March 5, 1874.—Dr. (now Sir) David Ferrier brought before the Royal Society his experiments mapping the surface of the brain of the monkey into regions whence minute electrical stimulation was found by him to evoke precise movements of the face and limbs, characteristic for each region. The experiments were made to test "the theory of Hughlings Jackson that unilateral epilepsies are caused by irritation of the grey matter of the cerebral hemisphere." Ferrier's experiments laid the foundation of the knowledge which guides the physician and surgeon in locating to-day the seat of injury, tumour, etc., in the cerebrum. Moreover, the success of the surgical operations on the monkey's brain obtained in those experiments made clear that similar success might be attained on the brain of man; and in 1884 Rickman Godlee removed a tumour from the human brain. E. C. S.

Societies and Academies.

LONDON.

Royal Society, Feb. 17.—**G. C. Simpson**: The mechanism of a thunderstorm. The theory that the separation of electricity is brought about by the breaking of raindrops is adopted. The orders of magnitude of the meteorological and electrical quantities involved are in accordance with observations. The observations made by Schonland and Craib in South Africa of changes of electrical field-strength produced by lightning discharges are in complete accord with the theory.

G. U. Yule: Wolfer's sunspot numbers considered as a disturbed periodic series. The series of sunspot numbers is analogous to the data that would be given by the observed departures of a simple pendulum subjected to random (or largely random) impulses. The graph of such a series is very smooth, but amplitude and phase are continually changing, just as with the sunspot graph. The problem of determining period and 'disturbances' for such a series is attacked by two methods: (1) By forming the least-square equation of the form appropriate to a simple harmonic function

$$u_x = ku_{x-1} - u_{x-2},$$

between three consecutive terms. Trial of the corresponding extended equation appropriate to two periods gave no evidence of the existence of any period other than the fundamental. (2) By forming the general least-square linear equation

$$u_x = b_1 u_{x-1} - b_2 u_{x-2},$$

and solving as a finite difference equation: the solution is a heavily damped harmonic function. The correlations between u_x and the preceding terms up to u_{x-5} again fails to give evidence of any period other than the fundamental. The 'disturbances' (divergences of u_x from the value estimated by the two preceding terms) show two conspicuous characteristics: (*a*) a tendency to be mainly positive and highly variable, mainly negative and much less variable, over alternate intervals of 40 to 42 years; (*b*) a tendency to be mainly positive during the rise of the graph, mainly negative during the fall.

H. Horrocks: Meteorological perturbations of tides and currents in an unlimited channel rotating with the earth. As tidal predictions from analysis of observations still differ considerably from observations, this paper aims at throwing light on the type of disturbance to be expected when conditions of wind and atmospheric pressure vary at the ocean surface. The special basin considered is an unlimited rotating channel with atmospheric conditions varying across it, and turbulence in the water is taken into account.

G. M. B. Dobson, D. N. Harrison, and J. Lawrence: Measurements of ozone in the earth's atmosphere and its relation to other geophysical conditions (Part 2). As previously found, there is a marked connexion between the amount of ozone and the meteorological upper-air conditions. Possible reasons for this connexion are briefly discussed and connexions with terrestrial magnetism and possibly with sunspots are indicated.

M. Bentivoglio: An investigation of the rate of growth of crystals in different directions. The crystal is grown in a rotating vessel, and relative rates of face-growth are determined for crystals of isomorphous double sulphates of magnesium-ammonium, iron-ammonium, and magnesium-potassium, and potassium and ammonium tartrates. The measurements show that, under conditions of experiments, (i) similar faces of a *simple* form grow at same rate, even when of different sizes. Hence a misshapen crystal, if grown under uniform conditions, *tends* towards the ideal form. (ii) On a combination, unlike faces grow at different rates, like faces grow at the same rate, except when adjacent to a large face of another fast-growing form. Except in this case there is a constant ratio between rates of growth of any two different forms. (iii) In crystals having no centre of symmetry, rates of growth of parallel faces may be widely different. (iv) In isomorphous series the order of increasing rates of growth is not the same in different members.

P. A. M. Dirac: The quantum theory of the emission and absorption of radiation. The problem is treated of an assembly of similar systems satisfying the Einstein-Bose statistical mechanics, which interact with another different system, a Hamiltonian function being obtained to describe the motion. The theory is applied to the interaction of an assembly of light-quanta with an ordinary atom, and gives Einstein's laws for the emission and absorption of radiation. The interaction of an atom with electromagnetic waves is then considered, and it is shown that if one takes the energies and phases of the waves to be q-numbers satisfying the proper quantum conditions instead of c-numbers, the Hamiltonian function takes the same form as in the light-quantum treatment. The theory leads to the correct expressions for Einstein's A's and B's.

Physical Society, Dec. 10.—**A. O. Rankine** and **J. W. Avery**: Electrical polarisation in selenium cells and the effects of desiccation. The secondary E.M.F.'s displayed by selenium cells and the apparently abnormal effect of illumination on the corresponding secondary currents were measured. Both are probably due to an invisible water film in parallel with the selenium. That this film is the principal seat of the polarisation seems to be proved by the fact that the polarisation disappears almost completely with prolonged drying. On this basis a satisfactory quantitative explanation of the various effects is given. An important practical consequence of the desiccation of the cell is the large increase obtained in its sensitivity to light.—**T. G. Hodgkinson**: Synchronous alternating-current motors and mechanical vibrating systems maintained by thermionic valves at the frequency of the vibrating systems. The design of a chronograph which will give a time trace subdivided into units and fractional units requires the association of a rotating system and a vibrating or time-keeping system. If a low-frequency vibrating system be employed, the rotating system, although keeping good average time, may show exaggerated errors in unit subdivisions due to acceleration and deceleration between periods of control. The paper discusses the association of a high-frequency synchronous alternating-current motor with a high-frequency valve-maintained tuning-fork.—**K. R. Rao**: (1) On the spectrum of ionised tin; (2) On the spectrum of doubly ionised gallium and indium.

LEEDS.

Philosophical and Literary Society, Jan. 25.—**J. Lamb**: A 15-ic resolvent of the sextic equation. If this resolvent—whose coefficients are all invariants—has a rational root, the sextic breaks up into three quadratic factors involving a cubic irrationality.—**H. Jones** and **R. Whiddington**: The passage of electrons through gases. Quantum energy losses appear to occur when low-speed electrons pass through gases at low pressure. These losses in some cases correspond with sufficient accuracy with previously known critical potentials, but in other cases do not so correspond.—**W. R. Atkin**: Development of the Sorensen equation for the isoelectric points of ampholytes. The isoelectric point of a simple ampholyte such as an amino acid is $h=\sqrt{k_w . k_a/k_b}$, but this equation is not valid for proteins where the terminal $-NH_2$ and $-COOH$ groups are not necessarily equal in number. The isoelectric point of proteins is given by the equation $h^2+k_a(1-n)h-n . k_w . k_a/k_b=0$, where n is the ratio of $-COOH$ groups to $-NH_2$ groups, and k_a and k_b represent average values of the acidic and basic dissociation constants.

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, Vol. 12, No. 12, Dec.).—**Arthur Bramley**: Maxwell's equations and atomic dynamics. Electric and magnetic forces within a charge are stated as functions of the velocities of the moving body and its position. This satisfies the first of Maxwell's equations and gives the second set as equations of motion of the charge; from the latter, Bohr's frequency condition can be derived.—**Lucien B. Taylor**: The spectrum of krypton in the extreme ultra-violet.—**C. H. Kunsman**: Some thermionic experiments with a new source of positive ions. Fused mixtures of iron oxide with about 1 per cent. of an oxide of an alkali or alkaline earth metal form a satisfactory hot anode in a vacuum tube. The positive ions emitted are single atoms, mostly of the added metal, stripped of one electron. Positive ions are emitted when the equivalent voltage of the work function for vaporisation of the ion is greater than the potential holding the outer electron to the atom.—**J. H. Van Vleck**: The dielectric constant and diamagnetism of hydrogen and helium in the new quantum mechanics. Whenever the quantum numbers are small, the theory developed here gives values more in accord with experiment than those of the old quantum theory.—**Richard C. Tolman**: On the equilibrium between radiation and matter. From the first and second laws of thermodynamics, an equation connecting concentration and temperature can be obtained. It contains a constant b, requiring a knowledge of the absolute entropy of the system; Planck's procedure, $S=k \log P$, where S is the absolute entropy and P is the total number of stationary states the energy of which does not exceed the total energy available, may lead to the evaluation of the constant b.—**R. C. Gibbs** and **H. E. White**: Extension of doublet laws in the first long period to chromium and manganese.—**Leonard B. Loeb**: Ionic mobilities in ammonia-hydrogen mixtures and an anomalous effect of ammonia. Traces of ammonia in hydrogen and in air increase the mobility of the positive ions by as much as 30 per cent. without affecting the negative ion, and the formation of a stable NH_4^+ ion which prevents clustering is suggested. 0·1 per cent. and more of ammonia decreases both ionic mobilities by about the same amount. Experiments to find if ammonia would 'protect' the positive ion from ether suggest that the ether molecule attaches to the positive ion in preference to the ammonia molecule.—**Carl Eckart**: Note on the correspondence principle in the new quantum theory. If the co-ordinate matrix is expanded in terms of Planck's constant, the first term approaches the coefficient of the $(m-n)$th harmonic in the Fourier expansion of the motion in the old theory when n approaches infinity. For large quantum numbers, the Fourier coefficients thus constitute a first approximation to the matrix terms, in accordance with the correspondence principle.—**M. Demerec**: Miniature-a—a second frequently mutating character in *Drosophila virilis*. This wing character 'mutates' to wild type at any stage in the life-history; it is sex-linked.—**Chas. W. Metz**: Genetic evidence of a selective segregation of chromosomes in Sciara (Diptera). Maternal chromosomes separate from the paternal ones, the maternal group always going to the pole to remain in the spermatocyte.—**Roscoe G. Dickinson** and **Allan C. G. Mitchell**: Decomposition of ammonia by optically excited mercury atoms. The photochemical decomposition is sensitised by mercury vapour illuminated by a cooled quartz mercury arc with radiations of less than 2340 Å.U. filtered off. Diffuse band fluorescence in the green and ultra-violet accompanies the action.—**J. M. Cork, C. James**, and **H. C. Fogg**: The concentration and identification of the element of atomic number 61. *L*-series lines of the new element were given by a neodymium concentrate obtained from a large quantity of Brazilian monazite sand.—**Gregory Paul Baxter** and **Howard Warner Starkweather**: (1) The density of oxygen and its compressibility below one atmosphere (ii). The average corrected normal density is 1·42897, the coefficient of deviation from Boyle's Law −0·00092 per atmosphere, and the molal volume 22·4144 litres. The atomic weight of helium (density 0·17846) is 4·0001, the last decimal place being without special significance. (2) The density, compressibility, and atomic weight of nitrogen. The average density at 1 atmosphere is 1·25036. The average of the coefficient of deviation from Boyle's Law between 0 and 1 atmosphere is −0·00045 and the average atomic weight 14·006(7).—**William D. Harkins** and **Hugh A. Shadduck**: The synthesis and disintegration of atoms as revealed by photography of Wilson cloud tracks (see NATURE, Dec. 18, 1926, p. 875).—**Hugh Stott Taylor** and **John Reginald Bates**: Photosensitised decompositions by excited mercury atoms. Various gases, with and without mercury vapour, were passed through a system including a cooled mercury arc; the difference in the rate of increase of pressure in each pair of experiments indicated the occurrence of decomposition. Water gives oxygen and hydrogen in excess, ethyl alcohol gives acetaldehyde and other decomposition products, benzene gives some diphenyl, and so on. Ammonia gives a big excess of hydrogen, suggesting decomposition by stages, probably through hydrazine.—**Cecilia H. Payne**: (1) Some applications of the ionisation formula. Graphical illustration of the principles of the comparison of the state of ionisation of the atmospheres of stars for which both temperature and pressure differ. Curves for pressure change at constant temperature give the ratio in partial electron pressure in the atmospheres of two stars of known temperature, if the intensity ratio of the corresponding spectrum line is known. (2) On the spectra of stars of class *cF*8.—**Willard J. Fisher**: The apparition dates of the Andromede (or Bielid) meteor swarms. The method used by H. A. Newton is applied to the known records of this shower. Apparitions may be expected yearly about Nov. 16-19. Three of the 'plots' converge at Nov. 16·7, 1935 U.T.—**Maynard M. Metcalf**: Larval stages in a protozoon. The Opalinidæ, which are commensals in the recta of frogs and toads, are arranged in an evolutionary table ranging from Protoopalina, an archaic genus of the Triassic, cylindrical in form and with two nuclei, through a flattened form, through another cylindrical form with four or more nuclei, to the flat Opalina, which may be broad or narrow. Opalinids from tadpoles showing all these varied stages in development have been found.—**S. Lefschetz**: Transformations of manifolds with a boundary.—**Paul Slavenas**: A possible way to discuss the fundamental principles of relativity. The method is applied to the motion of a rigid system relative to another in Euclidean space, and it is found that Euclidean space admits the law of uniform translation, and that the moving system undergoes contraction in the direction of motion.—**R. L. Moore**: Concerning paths that do not separate a given continuous curve. In space of two dimensions, every two points that do not belong to a given continuous curve may be joined by a simple continuous arc that does not disconnect that curve.—**W. A. Manning**: On simply transitive primitive groups.—**L. E. Dickson**: Quadratic forms which represent all integers.—**Luther Pfahler Eisenhart**: Congruences of parallelism of a field of vectors.—**Gordon T. Whyburn**: Concerning certain types of continuous curves.—**H. S. Vandiver**: Summary of results and proofs concerning Fernat's last theorem (second note).

Official Publications Received.

BRITISH.

The Journal of the Institute of Metals. Vol. 36. Edited by G. Shaw Scott. Pp. xi+785+58 plates. (London.) 31s. 6d. net.

The Journal of the Polynesian Society: containing the Transactions and Proceedings of the Society. Vol 35, No. 4, December. Pp. 267-354. (New Plymouth, N.Z.) 10s. 6d.

Memoirs and Proceedings of the Manchester Literary and Philosophical Society, 1925-26. Vol. 70. Pp. 151+xxxvi+iv. (Manchester.) 12s.

Aeronautical Research Committee: Reports and Memoranda. No. 1049 (Ae. 235). The Direct Measurement of the Angle of Flight Path of an Aeroplane as a means of eliminating the Effect of Air Currents on the Measurement of Lift and Drag. By B. T. Jones and H. L. Stevens. (C.1. Instruments, 91.—T. 2319.) Pp. 9+2 plates. 9d. net. No. 1061 (Ae. 236). Second Report on Full Scale Experience with the Slot and Aileron Control fitted to a Bristol Fighter. By H. L. Stevens. (A 2 b. Stability—Full Scale Experiments, 41.—T. 2330.) Pp. 8+2 plates. 4d. net. (London: H.M. Stationery Office.)

FOREIGN.

U.S. Department of Agriculture. Farmers' Bulletin No. 1494: Tobacco Cutworms and their Control. By S. E. Crumb. Pp. ii+14. 5 cents. Department Bulletin No. 1428: The Cadelle. By E. A. Back and R. T. Cotton. Pp. 42. 10 cents. (Washington, D.C.: Government Printing Office.)

Proceedings of the United States National Museum. Vol. 69, Art. 22: Descriptions of New and Little Known Diptera or Two-winged Flies. (No. 2648.) Pp. 26. (Washington, D.C.: Government Printing Office.)

Proceedings of the Imperial Academy. Vol. 2, No. 9, November. Pp. xxv-xxvi+459-519. (Ueno Park, Tokyo.)

Carnegie Institution of Washington. Annual Report of the Director of the Department of Terrestrial Magnetism. (Reprinted from Year Book No. 25, for the Year 1925-26.) Pp. 185-235. (Washington, D.C.: Government Printing Office.)

Acta Societatis Scientiarum Fennicæ. Tom. 50, No. 7: Recherches sur les mouvements propres des étoiles dans la zone photographique de Helsingfors, II. Par Ragnar Furuhjelm. Pp. 162. (Helsingfors.)

Department of Commerce. Bureau of Standards. Scientific Papers of the Bureau of Standards, No. 533: Relations between Rotatory Power and Structure in the Sugar Group. Part 1: Introductory Article and Articles 1 to 10. By C. S. Hudson. Pp. 241-334. 35 cents. Scientific Papers of the Bureau of Standards, No. 539: Radiometric Measurements on the Carbon Arc and other Light Sources used in Phototherapy. By W. W. Coblentz, M. J. Dorcas and C. W. Hughes. Pp. 535-562. 15 cents. (Washington, D.C.: Government Printing Office.)

Institut de France: Académie des Sciences. Annuaire pour 1927. Pp. 382. (Paris: Gauthier-Villars et Cie.)

Veröffentlichungen des Geophysikalischen Instituts der Universität Leipzig. Zweite Serie: Spezialarbeiten aus dem Geophysikalischen Institut. Band 3, Heft 3. Über Luftdruckwellen; synoptische Darstellung der 24 tägigen und der 8 tägigen Welle für die Zeit vom 10 Dezember 1923 bis zum 19 Febr. 1924. Von Paul Mildner. Pp. 173-239+9 Tafeln. (Leipzig.)

Cornell University: Agricultural Experiment Station. Bulletin 453: An Economic Study concerning the Operations of Fruit and Vegetable Shippers in Western New York. By Roger D. Corbett. Pp. 67. Bulletin 455: Sunflowers as compared with Corn as a Silage Crop for New York. By R. G. Wiggans. Pp. 29. Memoir 104: Pasture Studies. By R. G. Wiggans. Pp. 50+4 plates. (Ithaca, N.Y.)

Department of the Interior: Bureau of Education. Bulletin, 1926, No. 11: Residence and Migration of University and College Students. By George F. Zook. Pp. vii+127. (Washington, D.C.: Government Printing Office.) 20 cents.

Diary of Societies.

SATURDAY, FEBRUARY 26.

BRITISH PSYCHOLOGICAL SOCIETY (Industrial Section) (at Royal Anthropological Institute), at 11 A.M.—Dr. C. Delisle Burns: The Group Mind in Industry.

MERSEYSIDE AQUARIUM SOCIETY (at Liverpool University), at 3.—Prof. J. Johnstone: Address.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Associates' and Students' Section) (at Neville Hall, Newcastle-upon-Tyne), at 3.—W. Leebetter: Winning Thin Seams of Great Britain.—Papers open for further discussion:—Screening and Washing Plant at Deaf Hill Colliery, by L. F. H. Booth; Steam and Electric Locomotives for Colliery Purposes, by P. F. Hope.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. J. B. McEwen: Beethoven (1).

MONDAY, February 28.

Society of Chemical Industry (Joint meeting of Fuel and Yorkshire Sections) (at Queen's Hotel, Leeds), at 2.30.—The Influence of Atmosphere and Temperature upon the Scaling of Steel:—Dr. C. B. Marson and Prof. J. W. Cobb: Part I. Scaling by Air, Water Vapour, and Carbon-Dioxide.—Dr. H. T. Angus and Prof. J. W. Cobb: Part II. Prevention of Scaling by Hydrogen and Carbon-Monoxide.—Dr. A. Parker: A Thermal Study of the Process of Manufacture of Water Gas.—At 5.—R. A. Mott: A Study of Coke Formation.—H. Hollings: Coke in Relation to some of its Industrial and Domestic Uses.—Margaret F. Bligh and H. J. Hodsman: The Behaviour of Cokes in the Open Grate.

Royal Irish Academy, at 4.15.

Cambridge Philosophical Society (in Botany School, Cambridge), at 4.30.—R. E. Holttum: Some Problems of Plant Biology in Malaya.—*Papers to be communicated by title only*:—Dr. A. S. Parkes: The Mammalian Sex-Ratio.—Dr. V. Nath: On the Present Position of the Mitochondria and the Golgi Apparatus.—H. E. Tunnicliffe: Glutathione.—G. C. Steward: On Herschel's Condition and the Optical Cosine Law.

Institute of Actuaries, at 5.—E. W. Phillips: The Actuary in Commerce and Industry.

Royal College of Surgeons of England, at 5.—Prof. V. Z. Cope: Shock and Collapse, with special reference to Acute Abdominal Disease.

Institution of Electrical Engineers (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—Lt.-Col. K. Edgcumbe and F. E. J. Ockenden: Some Recent Advances in Alternating-Current Measuring Instruments.

Institution of Electrical Engineers (Tees-Side Sub-Centre) (at Cleveland Technical Institute, Middlesbrough), at 7.—J. R. Beard and T. G. N. Haldane: The Design of City Distribution Systems, and the Problem of Standardisation.

Royal Institute of British Architects, at 8.—H. Corbett: Organisation and Cost of the Building Industry in America.

Royal Society of Arts, at 8.—Prof. E. G. Coker: Photo-elastic Measurements of Stress Distribution (Cantor Lectures) (3).

Chemical Industry Club, at 8.—C. Ainsworth Mitchell: Expert Evidence in Criminal Trials.

Royal Society of Medicine (Odontology Section), at 8.—Dr. H. W. Barber: The Relationship of Diseases of the Skin to Dental Infection.—E. C. Sprawson: Further Notes on Dentigerous Cysts.

Hunterian Society of London (at Cutlers' Hall, E.C.), at 9.—W. G. Ball: The Value of Modern Methods of Investigation in the Diagnosis and Treatment of Hæmaturia.

University of Birmingham Chemical Society.—Prof. W. N. Haworth: Some Hetero-cyclic Compounds (Presidential Address).

TUESDAY, March 1.

North Staffordshire Institute of Mining Engineers (in Central School of Science and Technology, Stoke-on-Trent), at 4.—T. C. Maynard: Notes on the Re-opening of a Working District after Spontaneous Combustion.

Royal College of Physicians of London, at 5.—Dr. W. F. Dearden: Health Hazards in the Cotton Industry (Milroy Lectures) (1).

Royal Institution of Great Britain, at 5.15.—Prof. J. S. Huxley: Problems of Animal Growth and Development (5).

Child-Study Society (at Central Hall, Westminster), at 6.—St. John Ervine: The Drama and Education.

London Natural History Society (at Winchester House, E.C.), at 6.30.—Major E. E. Austen: Tse-tse Flies and their Significance to Tropical Africa (Lecture).

Institution of Electrical Engineers (East Midland Sub-Centre) (at University College, Nottingham), at 6.45.—J. R. Beard and T. G. N. Haldane: The Design of City Distribution Systems, and the Problem of Standardisation.

Electrical Power Engineers' Association (Midland Division) (at Chamber of Commerce, Birmingham), at 7.—C. Vernier: Super-Tension Cables.

Royal Photographic Society of Great Britain, at 7.—M. Terry: Northern Australia—An Account of my 1925 Expedition.

Institute of Metals (North-East Coast Section) (at Armstrong College, Newcastle-upon-Tyne), at 7.30.—Annual General Meeting.

Hull Chemical and Engineering Society, at 7.45.—Dr. W. H. Hatfield: Stainless Steel.

Institution of Automobile Engineers (at Royal Society of Arts), at 7.45.—H. R. Ricardo: Some Notes on Petrol-Engine Development.

Röntgen Society (at British Institute of Radiology), at 8.15.

Institute of Chemistry (Annual General Meeting).

WEDNESDAY, March 2.

Electrical Association for Women (at Hackney Electricity Showrooms, 18 Lower Clapton Road, E.5), at 3.—Discussion on Electric Cookers, from the Housewife's Point of View.

Royal College of Surgeons of England, at 5.—Sir Arthur Keith: Recent Researches carried out in the Museum.

Institution of Electrical Engineers (Wireless Section), at 6.—T. L. Eckersley: Short Wave Wireless Telegraphy.

Liverpool Engineering Society (at The Temple, Dale Street, Liverpool), at 6.—J. Wilding: The Mersey Crossings and Industrial Developments.

Institution of Civil Engineers (Students' Meeting), at 6.30.—L. G. B. Rock: The Construction of a Large Cleaning-shed for Electric Trains.

Institution of Heating and Ventilating Engineers (at Caxton Hall), at 7.—Discussion on paper by Dr. Margaret Fishenden on The Effect of Weather Conditions upon the Heat Requirements of a House.

Society of Public Analysts and other Analytical Chemists (Annual General Meeting) (at Chemical Society), at 8.—A. W. Knapp, J. E. Moss, and A. Melley: Cacao Butter Substitutes and their Detection.—Dr. H. W. Bywaters, F. T. Maggs, and C. J. Pool: The Detection of Illipé Butter in Chocolate.—A. F. Lerrigo and A. L. Williams: A Study of the Determination of Saccharin, Colorimetrically and by the Ammonia Process.

Royal Society of Arts, at 8.—U. R. Evans: The Corrosion of Metals at Joints and Crevices.

Eugenics Society, at 8.

Royal Society of Medicine (Surgery Section), at 8.30.—C. Max Page, Dr. Beddard, R. C. Elmslie, and others: Discussion on The Surgical Treatment of Chronic Non-tuberculous Arthritis.

Royal Microscopical Society (Biological Section).

THURSDAY, March 3.

Royal Society, at 4.30.—Prof. W. L. Bragg: The Structure of Certain Silicates.—M. Bentivoglio: An Investigation of the Rate of Growth of Crystals in Different Directions.—M. C. Johnson: Doppler Effects and Intensities of Lines in the Molecular Spectrum of Hydrogen Positive Rays.—W. L. Webster: The Transverse Magneto-Resistance Effect in Single Crystals of Iron.—*Papers to be read in title only*.—R. Mallett: A Vector Loci Method of Treating Coupled Circuits.—H. Gregory and H. Marshall: The Thermal Conductivity of Carbon Dioxide.—Prof. H. S. Allen and I. Sandeman: Bands in the Secondary Spectrum of Hydrogen.—Prof. C. G. Darwin and F. H. Watson: The Constants of the Magnetic Dispersion of Light.

Royal Society of Medicine (Balneology and Climatology Section), at 4.30.—Dr. C. McClure, Dr. Wybauw, Dr. F. Fox, and others: Discussion on The Breakdowns of Middle Life.

Royal College of Physicians of London, at 5.—Dr. W. F. Dearden: Health Hazards in the Cotton Industry (Milroy Lectures) (2).

Royal Institution of Great Britain, at 5.15.—Prof. J. Garstang: The Progress of Hittite Studies (2).

Child-Study Society (at Royal Sanitary Institute), at 6.—G. K. Jones: The Battersea Scheme of Children's Concerts and Cinema Shows.

Institution of Electrical Engineers, at 6.—J. W. T. Walsh: Illuminating Engineering.—H. T. Harrison: The Problems of Public Lighting by Electricity.

Institute of Metals (Birmingham Section) (jointly with Staffordshire Iron and Steel Institute and Birmingham Metallurgical Society) (at Engineers' Club, Birmingham), at 7.—Dr. E. W. Smith: Metal Melting Furnaces.

Society of Chemical Industry (Bristol Section) (Annual Meeting) (at Bristol University), at 7.30.—G. Gray: Science and Industry (Chairman's Address).

Chemical Society, at 8.—R. W. Lunt and R. Venkateswaran: The Decomposition of Carbon Monoxide in the Corona due to Alternating Electric Fields. Part II.—Prof. T. M. Lowry, L. P. McHatton, and G. G. Jones: The Properties of the Chlorides of Sulphur. Part I. Freezing-points.

FRIDAY, March 4.

Royal College of Surgeons of England, at 5.—Sir Arthur Keith: Recent Researches carried out in the Museum.

Royal Photographic Society of Great Britain, at 7.—Pictorial Group Meeting.

Photomicrographic Society (at 4 Fetter Lane), at 7.—A. E. Tonge: Notes on the Eggs of Lepidoptera.

Society of Chemical Industry (Liverpool and Manchester Sections) (at Manchester), at 7.30.—Dr. D. Clibbens: Chemical Control in the Cotton Bleaching Industry.

Junior Institution of Engineers, at 7.30.—Informal Meeting: An Evening with the Old Brigade.

Geologists' Association (at University College), at 7.30.—Dr. R. L. Sherlock: A Correlation of the British Permo-Triassic Rocks. Part II. The Permo-Trias of England and Wales South of the Pennines.

Philological Society (at University College), at 8.—Prof. D. Jones: Cardinal Vowels.

Oxford University Junior Scientific Club, at 8.15.—Prof. R. A. Peters: Nutrition in the Light of Modern Research.

Royal Institution of Great Britain, at 9.—Sir Herbert Jackson: Some Colouring Agents in Glasses and Glazes.

SATURDAY, March 5.

Royal Institution of Great Britain, at 3.—Dr. J. B. McEwen: Beethoven (2).

PUBLIC LECTURES.

SATURDAY, February 26.

Horniman Museum (Forest Hill), at 3.30.—C. Daryll Forde: Ancient Ships and their Modern Descendants.

SUNDAY, February 27.

Guildhall (Eccleston Square), at 3.30.—Prof. J. A. Thomson: The Naturalist's Approach to Religion.

MONDAY, February 28.

London School of Economics and Political Science, at 5.—Prof. H. J. Laski: The Political Philosophy of Spinoza.

King's College for Women (Household and Social Science Department), at 5.15.—J. Fletcher: Principles of Design in Furniture and Decoration.

TUESDAY, March 1.

Bedford College for Women, at 5.15.—Prof. H. H. Turner: Conceptions of the Cosmos in the Galilean and Newtonian Period.

WEDNESDAY, March 2.

University College, at 5.30.—W. H. Patterson: Volta.

THURSDAY, March 3.

King's College, at 5.30.—R. G. Collingwood: The Mind: Æsthetics.

FRIDAY, March 4.

King's College, at 5.30.—C. J. Gadd: Herodotus in Babylon.

SATURDAY, March 5.

Horniman Museum (Forest Hill), at 3.30.—H. Harcourt: Some Poisonous Snakes of India.

SUNDAY, March 6.

Guildhouse (Eccleston Square), at 3.30.—Dr. C. Delisle Burns: Experimental Religion.

SATURDAY, MARCH 5, 1927.

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A Representative Body for Science in Great Britain.

THE invitation sent out by the National Union of Scientific Workers to all those who have made science their vocation, to assist in building up an organisation which shall be fully representative of their various interests, may appear to some to be superfluous. They may argue that the functions which it is proposed this representative body should perform come within the scope of the legitimate activities of existing bodies, the various learned societies, propagandist bodies like the British Association and the British Science Guild, and the professional institutions the members of which are engaged in the teaching and practice of science. Others, while prepared to agree with the statement that none of the existing bodies is fully representative of science and the scientific worker, may feel that this is an advantage rather than a disadvantage, in that it is conducive to the freest expression of the will of the individual. They may fear that the establishment of a code of professional ethics, for example, might result in the growth of a narrow professionalism deadly to the spirit of science.

A hundred years ago similar objections were raised to the formation of the British Medical Association. Some qualified physicians, surgeons, and apothecaries on one hand, and all the quacks on the other, regarded this body with the greatest disfavour, the former because they resented the implication that the existing bodies were not all-sufficient and wished to safeguard their right to control their respective branches of the medical profession, the latter because they were fearful of the material consequences to themselves. Yet it cannot be seriously suggested that the peculiar form of professionalism which was established mainly through the initiative and instrumentality of the British Medical Association has not been of the greatest advantage to the members of that profession and even more to the public. It must be acknowledged that the type of professionalism which insists that the results of ameliorative research should be made available to the whole world, which insists also that the discoverers themselves shall not derive any immediate and direct pecuniary benefit from them, is expressive of the highest ideals of service and calculated to attract to the profession some of the finest spirits of the age. Neither can it be said that the prestige of the Royal Society of Medicine, the Royal College of Physicians or the Royal College of

Surgeons, or the faculties of medicine of the universities of Great Britain suffered through the activities of the democratically constituted body: actually their prestige was enhanced. The medical profession is practically a self-governing body, members of the profession predominate on the General Medical Council, and the Government puts large funds at the disposal of the Medical Research Council, most of the members of which, and the chief administrative officer, are also members of the medical profession. Moreover, they act in an executive capacity, and not merely an advisory capacity like the scientific members of the Committee of the Privy Council for Scientific and Industrial Research.

The suggestion that the proposed body for science is superfluous is disposed of by the signatories and supporters of the present appeal: among them are some who have held or are at present holding high offices in learned societies and professional institutions. In another category is the vague fear that such a body would tend to warp the spirit of the individual scientific worker or restrain his freedom of action in any way. Much would depend on the character of the restraint. It might quite reasonably recommend its members not to apply for appointments where low initial salaries were not compensated for by the prospects of a moderate competency later, or where other conditions of service were notoriously bad. But it is difficult to imagine in what other ways it would fetter the judgment of an individual. It can scarcely be imagined that it would demand a thirty-six-hour week, or that it would exhibit that peculiar vice of modern trade-unionism—the excessive demarcation of function—or even that it would proscribe certain types of research. It is obvious that it must do none of these things. On the contrary, one of its most important tasks might be the freeing of research workers in certain industrial undertakings and government departments and State-aided institutions from many of the unnecessary and irritating restraints from which they suffer to-day—conditions which are only possible because of the lack of organisation among the victims. Just as the British Medical Association broke down the narrow professionalism and exclusiveness of the older sectional organisations, so could the proposed body promote unity among the many distinct and overlapping sectional bodies in science.

It is a little unfortunate that the general newspapers, in commenting on the appeal, have unduly stressed its material aspect, and almost entirely ignored the wider aims outlined. Naturally, a body which exists for the purpose of furthering and protecting the interests of scientific workers must do all in its power to bring about an improvement of the salaries and other conditions of service of its members. The shortage of men and women of the first rank for research has been noted in nearly every report on scientific research which has lately been published, and this shortage is attributed to the slender material attractions of a career which demands not only a rare type of mind, but also the utmost perseverance and self-training. Amateurs of the type of Cavendish and Darwin are few in number. The ranks of research workers have now to be filled by those to whom science must be a profession. "Human nature," stated the *Observer* last Sunday, "would have to be more exalted than it is to secure that the highest gifts would always be devoted to the service of knowledge for a reward much lower than accrues to mediocre grades of business ability." Clearly, it is the duty of the profession of science to ensure that the value put upon its services is sufficient to attract the highest type of recruit.

More is, however, demanded. Scientific workers must be valued not only for their achievements in harnessing the forces of Nature to the service of man, for giving him a greater measure of control over his environment by their successes in the combat against the diseases which afflict human beings, animals, and plants; for the material blessings they bestow on communities, or for the potency of the lethal weapons they have devised. They must be valued for their greatest achievement, the habit of mind which their patient and persevering observations and inquiry has engendered. They can bring to the examination of world problems an outlook which cannot rest content with partial and incomplete solutions. Hitherto, they have been denied the opportunity of directing or sharing the control of the affairs of a civilisation for which they are mainly responsible. Again, the remedy lies with scientific workers themselves. They could, if they were united in a great resolve, make the nation understand the contributions they have to offer to its problems, social problems, industrial problems, problems of finance. It is essentially their function, and not primarily that of a government department, to state the aims and the needs of science, and how best those needs can be met. It is their paramount duty to insist that science should be adequately represented in the councils of the nation, and they could best accomplish that end if they presented the appearance of a disciplined force instead of unorganised or inchoate and impotent factions.

It may be thought that unity in science will be best accomplished by the formation of a federal council upon which the various learned societies and professional institutions can be represented, rather than by a body aiming at becoming representative of these varied interests on the basis of individual membership. Scientific workers must realise, however, that to be effective, a federal council must have executive authority. It must be in a position, should the necessity arise, to take action involving each and all of the constituent bodies without direct reference to them: in other words, the constituent bodies must delegate large powers to their representatives. The breakdown of the Conjoint Board of Scientific Societies was largely due to the reluctance of the various societies to grant their representatives any such authority; and, in the end, to the Royal Society deciding not to support an appeal to Government for increased aid for the publication of scientific papers. Other attempts to obtain concerted action by the various societies have been equally unfortunate. On the other hand, if scientific workers are of opinion that a representative body able to speak with the authority of the majority of men and women professionally qualified for scientific service by their university degrees or other qualifications, is desirable for the advance of science and civilisation, they should make their wishes known.

Modern Geophysics.

Lehrbuch der Geophysik. Herausgegeben von Dr. B. Gutenberg. Lieferung 1. Pp. 176. 9·75 gold marks. Lieferung 2. Pp. 177-400. 13·80 gold marks. (Berlin: Gebrüder Borntraeger, 1926.)

GEOPHYSICS has now its 'Lehrbuch'; at any rate, it has two-fifths of one at the moment of writing, and the remaining instalments are promised for an early date. The difficulty that no single author can cover the whole subject has been met by obtaining the collaboration of a number of authors, and the whole is under the editorship of Prof. B. Gutenberg, whose distinguished work has already led to great advances in seismology and the study of the propagation of sound. The first two parts are by Profs. A. Born, E. A. Ansel, A. Sieberg, J. Bartels, and Gutenberg himself.

The opening chapter consists of three pages on cosmogony by Born, and gives short summaries of the nebular and planetesimal hypotheses of the origin of the solar system. It is rather unfortunate in mentioning work of mine in support of the planetesimal hypothesis; though the hypothesis I favour starts with the same initial assumptions as the planetesimal hypothesis, to the authors of which I have often expressed my indebtedness, it happens that the principal modification I have found necessary consists in dispensing with the planetesimals, and consequently a different name is needed for the theory I have advocated. The author decides that the primitive earth was fluid; this agrees with my own views, but not with the original form of the planetesimal hypothesis.

Prof. Born then gives a condensed account of the classification of rocks, with much useful information about their composition, mechanical properties, and thermal conductivity. Such information in an accessible form has long been needed; most analysts seem to think that it is much less important to know the density of a rock than whether it contains 0·3 or 0·5 per cent. of titanium. On p. 8 aluminium has somehow escaped mention as a constituent of felspars.

The composition and radioactivity of meteorites are then described, and Prof. Born goes on to the abundance of the chemical elements in the crust. The greater density and basicity of suboceanic rocks in comparison with continental ones are brought out. Data concerning radioactivity are given, but thorium contents are given only for basalts. A very good account of methods of determining geological time follows; De Geer's method for post-glacial time is included. The main geographical features of the earth are described in the next chapter.

There is a remark on p. 52 that the melting-point of basaltic rocks at atmospheric pressure is about 200°-300° C. lower than that of granite ones, which is given as 1100°. F. W. Clarke gives 1240° for granite, and values from 1060° to 1250° for basalt ("Data of Geochemistry," 1924, 298-301). J. H. L. Vogt gives 1250° for the crystallization point of gabbro, which is chemically similar to basalt, and 1000° for granite ("Economic Geology," 1926, 207-233). The latter estimates refer explicitly to dry material, but it seems to be generally believed by geologists that in natural conditions the melting-point of granite is more affected by water than that of basic rocks. A reconsideration of the data on this question is overdue; such a conflict of opinion on some of the most important experimental data of geophysics should not be allowed to persist.

A useful discussion of gravity and isostasy by Prof. Ansel follows. The account of the differences between the Airy, Pratt, and Hayford views of isostasy is clear and good, and there is a short account of the figure of the earth. The method of reduction of gravity observations is described, with special application to European data.

Movements of the crust are then treated by Prof. Born. Those on a continental scale are treated shortly, and then there is a description of the processes involved in the formation of mountains, with many excellent illustrations and accounts of relevant experiments. Pp. 122-125 are concerned with objections to the contraction hypothesis in general, not merely to the thermal contraction hypothesis. All seem to me quite unsound. One is that the strength required in the crust if it is to support itself like an arch without resting on the interior is many times the crushing strength of rock materials. Of course: but who has said that the crust had to become detached from the interior before it could be crumpled?

Phenomena of denudation and vulcanism are discussed in the next two chapters, mainly quantitatively.

The section on earthquakes in relation to geology is by Prof. Sieberg. It is concerned mainly with macroseismic data; there are several striking illustrations showing the fractures, rotations, and other disturbances produced in the neighbourhood of an earthquake. In addition to the ordinary scales of intensity, Prof. Sieberg gives one of his own adapted to disturbances felt at sea. The relations of earthquakes to volcanic and tectonic disturbances, and the physical processes involved in earthquakes, are then treated at considerable length.

The chief types of seismographs are described by Gutenberg in the next chapter. A novelty is an account of the torsion seismograph of Anderson and Wood, which depends on a cylinder mounted on a vertical wire in such a way that its centre of mass is not on the wire. Horizontal disturbances of the ground displace the wire and cause the cylinder to rotate about it. Then Gutenberg proceeds to consider the information yielded by the records of distant earthquakes. Most of his work on this subject has already been published, but not in so convenient a form, and it is so important that a connected account of it is invaluable. On pp. 245-6 tables derived from observation show the times of transmission of the direct *P* and *S* waves through the earth. These times are mostly rather shorter than those obtained by Zöppritz and still used as a basis for reductions by Turner; the differences for *P* reach about 12 seconds when the epicentral distance is 90°, while those for *S* are on the whole rather less.

Gutenberg's times have been derived from a discussion of many more earthquakes than were available when Zöppritz wrote, and have been supplemented by the amplitudes of the displacements observed, which afford a valuable check on the times measured directly. In addition, he has used these times to calculate the times of transmission of the various other waves theoretically possible. Following up some earlier work of R. D. Oldham, Gutenberg has found that the earth has an extensive central core where the *S* (distortional) wave is not transmitted, and the *P* (compressional) wave travels much more slowly than in the outer parts. This opens up the possibility that any wave incident on the boundary of this core will be broken up into three new waves—compressional waves in both shell and core, and a distortional wave in the shell. Waves incident on the outer surface, again, in general give rise to both compressional and distortional reflected waves. The waves transmitted into the core can undergo further separations when they emerge from it, so that on the whole a very complex picture is presented of the motion produced by a single earthquake shock. In the figure on p. 247 there are 16 curves showing the times of transit of waves to different distances; originally only three of these were empirical, and all the others are direct inferences from these three by means of the ordinary laws of wave propagation. I believe I am right in saying that every one of these curves has been verified by tracing the derived waves on actual records.

Near earthquakes and surface waves are then discussed, with several other interesting seismological questions, and Prof. Gutenberg then passes on to water waves and tides. The bodily tide, precession and nutation, and the variation of latitude are well, if somewhat briefly, discussed. The last twenty-three pages form the beginning of Dr. Bartels' article on terrestrial magnetism and related phenomena.

That the book should be in the possession of every geophysicist need scarcely be said. Nevertheless one feels at times that the authors' style is cramped for lack of space, and that geophysics is too large for one text-book, even one of a thousand pages. Still the amount of information compressed into the first four hundred pages is astonishing.

Harold Jeffreys.

Intellectual Activities in France.

Statistique intellectuelle de la France: tableaux relatifs à l'enseignement public, aux bibliothèques, aux spectacles, aux publications, préparés sous les auspices de l'Institut International de Coopération Intellectuelle et de l'Institut de Statistique de l'Université de Paris. Par Tatiana Beresovski-Chestov. Année 1923–24. Pp. vii + 124. (Paris: Les Presses universitaires de France, 1926.) 35 francs.

USUALLY, if one wants to discover detailed and comprehensive statistics concerning all kinds of educational machinery from primary, secondary, technical, and art schools to libraries, and even theatres, they must be sought in many (and often elusive) publications. Here they appear in one volume—a recommendation in itself.

It would be easy, of course, to succumb to the usual temptation presented by such a volume, namely, to compare its figures with those available in Great Britain. That is, however, a temptation we shall resist for three reasons. First, it is very difficult to make trustworthy comparisons where various parts of the machinery and their several objectives do not exactly correspond to those in Britain. Secondly, considerations of space would force us to select only those parts of the machinery in which we are specially interested; and, lacking the exact correspondence already mentioned, we would merely confirm the haters of statistics in their sweeping assertion that figures can be made to prove anything. The third reason, however, is the most important. It is that the idea behind this volume is not merely the presentation of many figures which uncontrolled enthusiasts may use to show how much more should be done in the fields which interest them most, or which railers against taxes may use to show in what manner public money is wasted. Nor is it, in the slightest degree, a defence of administration. It is a definite recognition that departmental statistics afford no real evidence of the intellectual progress of a country.

Not yet is it sufficiently realised that education is a process by no means confined to the school. There are libraries and pictures; theatres and cinemas; churches and museums; books and companions: there are also thoughtless parents and heedless employers; and who will doubt the enormous influence of the Press? All these, and countless other important and often unnoticed influences, go to make up the forces which determine intellectual progress. Only when their interlacing and interdependent qualities become more clearly perceived will the waste and sprawling disorder of the methods by which we try to advance become capable of scientific handling and direction.

To the question of how is this perception to be achieved, there are doubtless as many answers as there are difficulties to be overcome; and one of the many difficulties arises out of our inevitable drive towards specialisation—in education no less than in other fields. As the specialist becomes more immersed in his own developing activities, he often becomes less inclined to do more towards co-operation than to utter phrases of pious generalisation in public, while in private he is apt to become contemptuous of what he regards as intrusion. To criticise this attitude too severely is futile. It is, after all, quite comprehensible and is based upon a sound enthusiasm which is of vital importance to the swift destruction of the varied barriers against man's completer knowledge of his environment. Nevertheless, it must never be forgotten that specialisation achieves its highest value only by reason of its relationship to the great unity of knowledge which serves mankind.

In Great Britain the tendency to draw together activities in order to obviate lonely and superfluous endeavour has recently found practical expression—particularly in the direction of securing a clearing-house for all kinds of specialised information—in the formation of the Association of Special Libraries and Information Bureaux. On the statistical side, it is in the category of such movements that we would place the present volume. It does not pretend to be so complete as might be desired. It is, indeed, frankly admitted that the lack of certain information makes the work fall short of the ideal which has inspired it. Its value, however, cannot be over-estimated, and we shall look forward to the next volume (1924–25) which is already promised. In the meantime we cannot do better than conclude by quoting a passage from the introduction:

> "Une publication comme celle-ci fait comprendre à quel point nous sommes loin de donner au public les renseignements qui serviraient à évaluer la grandeur et la nature de la production française dans les sciences, les arts, les lettres et l'enseignement et en général l'importance de l'activité intellectuelle de la France. L'Institut International de Coopération Intellectuelle a fait savoir qu'il demanderait à tous les États de bien vouloir examiner les moyens de multiplier les relevés statistiques relatifs à la vie intellectuelle, suivant un plan qu'il leur proposera. Il est certain que l'apparition simultanée de statistiques bien faites sur l'activité intellectuelle de chaque pays pourrait singulièrement servir au progrès général."

Gmelin's 'Handbook.'

Gmelin's Handbuch der anorganischen Chemie. Achte völlig neu bearbeitete Auflage. Herausgegeben von der Deutschen Chemischen Gesellschaft. Bearbeitet von R. J. Meyer. Unter beratender Mitwirkung von Franz Peters. (1) System-Number 13: Bor. Pp. xix + 142. n.p. (2) System-Number 5: Fluor. Pp. xvi + 86. n.p. (Leipzig und Berlin: Verlag Chemie, G.m.b.H., 1926.)

INORGANIC chemistry has been so completely transformed within recent years that long before the completion of the seventh edition of Gmelin's well-known treatise, an entirely re-fashioned and comprehensive work, showing but little resemblance to the older editions, has been undertaken by the German Chemical Society. Except for the non-valent gases, which are all grouped into the first section, each element is being issued as a separate part under a specific 'system-number' (not identical with its atomic number), and it is expected that seventy separate parts will ultimately be issued within a decade and that the whole will form twenty-two volumes. Compounds of two elements will be found under the element of the higher serial number. Thus a particular subject will often be divided, *e.g.* boron carbide falls under carbon, whilst boron sulphide falls under boron, but an alphabetical index of subject matter becomes unnecessary. At the beginning of each section on one element there is a full table of contents, a list of abbreviations, an alphabetical register of journals to which reference is made, and also a complete list of system-numbers to facilitate the location of a compound in the complete work.

(1) In order to adhere to the general plan and at the same time to impart to the section on boron a certain independence, it has been found advisable to include condensed but freely annotated accounts of certain topics, which will be discussed in fuller detail at a later stage, *e.g.* several pages are devoted to a description of metallic borides in general, to heteropolyboric acids and organic complexes, and to perborates. The literature has been exhaustively studied—not merely transferred from earlier editions—to the end of 1925, but an addendum of seven pages includes some later material. Several diagrams are inserted in illustration of the relation between electrical conductivity and temperature, the influence of alcohols on the solubility of boric acid, etc.

(2) The section on fluorine is illustrated with excellent diagrams of the apparatus used by Moissan in 1887 in isolating the element, and of the modifications used later by Argo, Meyer, and Sandow, and by Simons. The history of the element, the general and physical properties, electrochemical behaviour and preparation of its compounds, are all dealt with in detail and a considerable amount of attention is given to analytical methods. A comprehensive survey of the results of atomic weight determinations from 1814 to 1925 is included. Amongst optical properties are found values of atomic refraction, wave-lengths in the arc and spark spectra, and even quite recent direct measurements of the *Kα* line obtained by X-ray analysis. The literature has been revised to the middle of 1926. Complex fluorides are catalogued in eight (periodic) groups, with formulæ and a full list of references.

Each part is bound in stiff-paper covers and clearly printed. When complete the 'Handbuch' will be an indispensable work of reference to the specialists in both pure and applied inorganic chemistry, and it will assuredly lighten the tedious labour involved in searching the literature.

Electrometric Methods.

(1) *Hydrogen Ion Concentration: its Significance in the Biological Sciences and Methods for its Determinations.* By Prof. Leonor Michaelis. Vol. 1: *Principles of the Theory.* Authorised translation from the second revised and enlarged German edition by Dr. William A. Perlzweig. Pp. xiv + 299. (Baltimore, Md.: Williams and Wilkins Co.; London: Baillière, Tindall and Cox, 1926.) 22*s.* 6*d.* net.

(2) *Potentiometric Titrations: a Theoretical and Practical Treatise.* By Dr. I. M. Kolthoff and Dr. N. Howell Furman. Pp. xii + 345. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1926.) 22*s.* 6*d.* net.

(3) *Les ions d'hydrogène: signification, mésure, applications, données numériques.* Par W. Kopaczewski. Pp. ix + 322. (Paris: Gauthier-Villars et Cie, 1926.) 70 francs.

(1) OF recent years the application of potentiometric methods to the determination of conditions of equilibria in aqueous solutions as well as to quantitative analysis has assumed proportions of no inconsiderable magnitude, and has thus created a demand for text-books on the subjects. To English readers the appearance of the second edition in English of Michaelis's well-known volume will prove a welcome addition to the text-books, few in number, which are universally appreciated. It is unfortunate that in this edition the

erroneous calculations of Ghosh, pp. 117-120, on the conductivity of strong electrolytes, have not been eliminated or replaced by those of Milner and Debye and Hückel. The book is specially valuable, as it is the only one of which the reviewer is aware in which the various types of electrification which can be produced at interfaces are described and discussed. In biology, at least, phase boundary membrane and electrokinetic potentials appear to be of the greatest significance.

(2) The volume of Kolthoff and Furman covers a somewhat different field. Here emphasis is laid on the more recent work on oxidation reduction potentials as well as the employment of metal electrodes in volumetric potentiometric analysis. The book is very well written and the conditions necessary for accurate work fully described. Possibly the weakest portion of the text is the descriptive portion in Chapts. vii. and viii. There are many simple and accurate potentiometers now on the market, such as that constructed by the Cambridge Instrument Co. designed specially for this work. These are now employed almost universally in research laboratories and works, and a short description of such might well replace some of the more complicated but no more accurate systems described. It is interesting to note that adsorption of precipitating ions may cause quite serious errors in the end points of various volumetric titrations in which precipitates are formed.

(3) Kopaczewski has confined himself to the potentiometric and colorimetric methods for the determination of hydrogen ions. The theoretical discussion on the nature of electrolytic dissociation and on the various activity coefficients is treated very inadequately, whilst the remainder of the book, chiefly experimental in character, follows the usual course. Eric K. Rideal.

The General Theory of Relativity.

Les équations de la dynamique de l'éther. Par Prof. Henri Eyraud. Pp. iii + 67. (Paris: Albert Blanchard, 1926.) 12 francs.

THIS monograph, dealing with the general theory of relativity, has a particular interest of its own in so far as it deals with a novel application of a recent generalisation of M. Cartan to the dynamics of the ether. Besides a brief historical introduction of three pages, and an appendix of nine pages on the technique of space and time measurements, there are two chapters, one of nearly thirty pages, dealing with the geometry of the spaces of the relativity theories, and another of nearly twenty pages dealing with the application of the principle of least action to the theories of gravitational and electromagnetic fields.

The first chapter works out, by traditional methods, the generalisation of M. Cartan already referred to, in which the components Γ^i_{jk} of the affine connexion in Weyl's geometry are no longer assumed to be symmetric in the two lower indices. Consequently a new true tensor arises, namely, the *torsion* $\Lambda^i_{jk} = \Gamma^i_{jk} - \Gamma^i_{kj}$, which plays an important part in the geometry of the generalisation of Weyl's space. The second chapter, which is the novel part of the monograph, introduces an action integral after the fashion of Mie and Weyl, in which the action density is assumed, initially, at all events, to be a function of two tensors of the second order: one, the skew symmetric electromagnetic tensor, which is the rotation of the contracted components of the affine connexion, Γ^k_{jk}, and the other, the gravitational tensor, which is the symmetric part of the contracted Riemann-Christoffel tensor, R_{ij}.

The ether thus defined is deduced from a Riemann space by a projective conformal transformation, and that the vector potential of the electromagnetic tensor, apart from a numerical factor, can be identified with the contracted torsion tensor $\Lambda_j = \Lambda^k_{jk}$. With the action density so far defined as a function merely of the electromagnetic and gravitational tensors, the ether is empty, that is, devoid of electric charge and current. When, however, the action density in addition is an explicit function of the contracted torsion tensor, the current vector appears as the partial differential coefficient of the action density with respect to the new tensor. A plausible assumption as to the form of the action density in the general case leads to an energy tensor of the usual type, with a part representing the electromagnetic energy, another part representing the electronic energy, and generally a third complementary part, which has the character of a pressure. The additional hypothesis that the action density depends mainly on the gravitation potentials, g_{ik}, whilst the influence of the electromagnetic and current terms is comparatively small, leads to the results that (1) the Lorentz electrodynamics holds, (2) the atoms are bounded universes with constant total curvature, and (3) the complementary energy is absent, both in the ether and the atoms.

The monograph is very concise, but offers no particular difficulty for readers familiar with the technique of the general theory of relativity. For such readers it will prove to be most interesting.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of Nature. *No notice is taken of anonymous communications.]*

The Atomic Weight of Silver.

In Nature of Dec. 11, 1926, reference is made to the determination of the atomic weight of silver (*Trans. Chem. Soc.*, 1926, p. 2510) by H. Brereton Baker and H. L. Riley, who, by determining directly the ratio Ag : O in pure silver oxide have obtained the value 107·864 ± 0·0013. This work, carried out with the greatest ingenuity and with care and exactitude such as has only been reached by Th. W. Richards and his school, is of cardinal importance. As I have the honour to be chairman of the Sub-Committee for Atomic Weights of the International Commission on Chemical Elements, I have perhaps the right, as well as the official duty, of offering a few critical remarks. I may be allowed to add that I have studied the literature of atomic weights for fifty years and I was the first to propose, in 1888, the adoption of O = 16 as the standard of atomic weights. A like proposal was made almost simultaneously by Venable in America, and, as is well known, this has become the established practice. As the atomic weights of elements cannot as a rule be determined directly in relation to oxygen, secondary standards are required, and the most modern work published by Richards and his school is being carried out by finding the ratios $x\mathrm{Ag} : \mathrm{RCl}_x$ or $y\mathrm{Ag} : \mathrm{RBr}_y$ to determine the atomic weight of R.

The atomic weight of silver has hitherto been a relative quantity, depending upon the atomic weights of other elements, especially chlorine, potassium, lithium, and nitrogen. As I have shown in critical articles in Abegg's 'Handbook,' it must lie between 107·876 and 107·871, and this view was adopted by the International Commission for Chemical Elements in 1925. In this way the classical value 107·930 of Stas (1865) (declared by Ostwald to be exact to the limit ±0·004 !) was superseded.

The best determination of the atomic weight of silver published by the Richards school led them to regard the value 107·876 as probably the best, and I agreed with them.

The acceptance of the results given by Baker and Riley would affect the whole series of results of the Richards school, and if we accept 107·864, chlorine would become 35·452–35·450 and nitrogen 13·999, values highly improbable having regard to the whole chemical and physical-chemical work bearing upon these elements.

After a very careful study of the paper of Baker and Riley, I beg permission to point to a possible experimental error which appears to have been overlooked by the authors. They decomposed silver oxide by heat and fused the metallic silver so obtained in an atmosphere of hydrogen. They do not seem to have considered whether silver is not volatile at its melting point, 960°·5, or a little above this temperature. Now Stas distilled silver with the oxyhydrogen flame, and I found in my work on the atomic weight of tellurium that it may be easily distilled by the flame of air and coal gas. Even on an open support of lime, silver is volatilised by using an ordinary blowpipe, a copious brown deposit (of oxide or possibly colloidal silver) being formed. On heating the metallic silver obtained by the method of Stas in a tube of the hardest Bohemian glass in the vacuum of a Sprengel pump, I found that at a dull red heat a distinct ring of fine particles of metallic silver was deposited on the cooler part of the tube. Silver, therefore, must have a small but appreciable vapour tension even at 400°-500°. Prof. H. Krepelka has observed repeatedly that on heating the purest, finely divided ('atomic weight') silver to its melting point in hydrogen, a distinct sublimate of small globules of metallic silver was formed on the cooler parts of the silica tube. From this I conclude that metallic silver is volatilised to a small extent at a temperature near 1000° to which Messrs. Baker and Riley heated it and fused it in hydrogen. Thus they would find their atomic weight too low.

The question arises what would be the magnitude of this source of error. If we assume the real value of the atomic weight to be 107·871 or 107·876, we can recalculate the data. I have done this, and find that if we attribute the difference of Baker and Riley's value from the value 107·871, the loss of silver on fusing would lie between the limits of 0·13 milligram and 0·006 milligram; if we take silver as 107·876, the loss would lie between the limits of 0·20 milligram and 0·06 milligram. If we take the mean atomic weight 107·864 given by Baker and Riley, the losses would be respectively 0·08 milligram and 0·14 milligram.

These quantities are so small that the silver corresponding to them would not be visible in any way in the quartz tube. I confess that I am surprised to find the above values so small, but I offer an explanation and give details in the full paper that will be published elsewhere.

May I say, in conclusion, that many years ago I contemplated a direct determination of the ratio of the atomic weights of silver and oxygen by reduction in hydrogen or in a mixture of hydrogen and nitrogen at the lowest possible temperature, but I could not carry out this most difficult and delicate work alone.

Bohuslav Brauner.

Bohemian University, Prague.

Thanks to the courtesy of the Editor of Nature, we are able to reply at once to the very kindly expressed criticism of Prof. Brauner. He considers that there is a possible source of error in our recent determination of the atomic weight of silver owing to the loss of traces of silver, by volatilisation, during its final melting in hydrogen. It is certain that, at the temperature of 900°, silver does give off some vapour, but we are convinced that no silver left the weighed tube. The silica tube was 17 cm. in length, not more than half of which was heated in the furnace. The rest, shielded from the heat of the furnace by asbestos board, together with the ground joint and narrow glass tube, has a length of 20 cm. They were kept cool by fanning during the whole time of the experiment. The current of hydrogen was very slow, about one bubble in 3 seconds.

It is not possible that the silver, which may volatilise at 900°, should escape in the state of vapour. If it escaped at all, it must have been in the form of fine particles of solid metal, and it seems almost inconceivable that no deposit should ever have been observed throughout the eight years during which the experiments have been going on. In the last eighteen determinations the same pair of silica and glass tubes has been used, and microscopic examination fails to reveal any trace of deposit on the part of the silica tube which was cooled, or in the glass tube. A more certain proof, however, is given by the weighings. In each determination the silver was melted several times in the silica tube until its weight was constant to one or two hundredths of a milligram. If there had been any such loss as Prof. Brauner has suggested, such constancy could never have been attained; the weight of the tube would have shown a constant diminution.

The knowledge of the atomic weight of silver is, as Prof. Brauner says, of such importance, that we have begun a new series of experiments to investigate the volatility and condensibility of silver.

H. B. BAKER.
H. L. RILEY.

Imperial College of Science,
London, S.W.7.

A New Method of Measuring the Absolute Surface Area of a Metallic Catalyst.

IN a previous communication (NATURE, vol. 118, p. 730; 1926) it was shown that simultaneous measurements of the electrical conductivity, and the thickness of the oxide layer on a film of metallic copper supported on china-clay rods, enabled the fractional decrease in surface area on sintering to be evaluated.

The thickness of the oxide film was measured by observation of the surface colour. These results give directly the equivalent air thickness of the oxide film, but to convert them into absolute measure the refractive index of the film must also be known. The mineral cuprite, cuprous oxide, has a refractive index of 2·85 and is cubic; whereas cupric oxide, occurring in the mineral kingdom as tenorite, is anorthic, having values of the refractive index of 2·63 for red light, and 3·18 for blue. Cuprite is translucent, having a red colour; tenorite is more opaque, occurring in scaly black crystals.

The colours shown by the oxide films are so marked that it is evident that in very thin films the absorption is almost negligible in amount. Since the oxide film is of higher refractive index than the air above it, the dispersion will tend to exaggerate the colours shown by films of a given thickness. The film is backed by metallic copper, and it is assumed that the path difference is caused by the passage of the light from the top of the film to the reflecting interface at the bottom and back again. With substances of such high refractive indices, the light in the film will be practically normal to the film in spite of the varying angles of incidence.

Let S = the surface area of the metal forming M grams of oxide spread over the china-clay support;
C = the electrical conductivity of the film;
q = equivalent air thickness of the oxide film;
μ = refractive index of the oxide;
ρ = density of the oxide;
k_c = initial value of the constant in the parabolic law for the fall in conductivity;
k_q = initial value for the equivalent air thickness.

Then the rate of formation of the oxide as a fraction of the total oxide possible

$$\frac{\rho . S}{M . \mu} \cdot \frac{dq}{dt}$$

is equal to the rate of disappearance of the metal, expressed similarly, *i.e.*

$$\frac{1}{C} \cdot \frac{dC}{dt}.$$

Hence we have

$$\frac{S}{M} = \frac{dC/dt . \mu}{dq/dt . C . \rho} = \frac{\mu}{\rho . C}\sqrt{\frac{k_c}{k_q}} . \quad . \quad . \quad . \qquad (1)$$

For an activated copper film the following values were found, k_c and k_q being measured at 210° C.:

$k_c = 1{\cdot}52 \times 10^{-2}$; $k_q = 2{\cdot}50 \times 10^{-10}$; $\mu = 2{\cdot}85$ (mean); $c = 0{\cdot}64$; $\rho = 6{\cdot}3$.

Therefore S/M = 5500 sq. cm. per gram of metallic oxide formed.
= 6900 sq. cm. per gram of film.

The area of the supporting china-clay rods for each gram of metallic film was 3200 sq. cm.

It is now possible to complete the comparison of the surface activity of pure electrolytic copper with that of activated reduced copper (*Proc. Roy. Soc.*, A, vol. 110, p. 285; 1926). 2000 sq. cm. of electrolytic copper had an activity that was imperceptible at 370° C., whereas the activity of about 70 sq. cm. of reduced copper was easily detected at 200° C. From the temperature coefficient of the reaction the activity of 540,000 sq. cm. of electrolytic copper would have been imperceptible at 200° C.; hence reduced copper has an activity that is at least 8000 times greater than that of electrolytic copper.

The activity of the smooth surface is very small indeed when compared with the reduced product.

These results, while showing very clearly the order of magnitude of the surface presented by reduced copper, cannot yet be regarded as accurate determinations until the growth of the oxide film has been studied by spectrometric methods. This research is now proceeding.

F. HURN CONSTABLE.

St. John's College,
Cambridge.

Spectrographic Observations of the Second Green Line of the Auroral Spectrum.

IN previous papers on the origin of the auroral spectrum, and recently in a letter to NATURE of Dec. 4, 1926, I have directed attention to the existence of a second green line lying in the region of about λ5230, which should correspond to the line, or rather group of lines, N_2, of the spectrum from solid nitrogen.

As stated in my letter to NATURE, this second auroral line is usually extremely faint and has only occasionally been observed with spectroscopes; in consequence, various observers have found values of the wave-length which differ within fairly wide limits.

On account of the faintness of the line, and also of the fact that the usual photographic plates have a minimum of sensitiveness in this region, I was not able during the early years of my work to obtain this line on my plates.

On a spectrogram made last autumn, however, on a panchromatic plate, I obtained for the first time, after an exposure of forty northern-light hours, this second line; but it was too faint for accurate measurements. The wave-length obtained was 5223.

After this spectrogram had been taken I was able to obtain a sensitiser which gave the plates a high sensitivity in the region wanted. The first exposure with this plate was made in a small spectrograph with fairly high light power and a broad slit. It was exposed at the Geophysical Institute of Tromsø for fifteen effective northern-light hours. On this spectrogram, which gave the ordinary auroral lines much over-exposed, I also now obtained this second green line very well marked on the plate.

The accompanying reproduction (Fig. 1) shows the strong green auroral line marked by *a*, the second green line by *b*, and the strongest lines of the negative band spectrum by *c*, *d*, *e*.

It will be noticed first of all that the second green line is not sharp; although much weaker than the other lines, it covers a greater part of the spectrum. Measurements showed the breadth of the second green line to be 0·22 mm., while that of the other lines, although more strongly exposed, was only 0·15 mm.

From this we can conclude that what is called the second green line is not a single line, but consists of a group of lines.

As stated in my previous letter to NATURE, this is also the case with the N_2 line from solid nitrogen. This fact, which has also been confirmed by McLennan, was taken by him to be an argument against my theory. We see, however, that the spectrogram obtained for the second green line, on the contrary, in this respect has confirmed my view with regard to the origin of the auroral spectrum.

On account of the small dispersion and the broad slit we cannot at present find the wave-length of the various components of the second green line; we have only been able to measure the wave-length of the maximum and limits of the band obtained by our plate. The limits are λλ5220-5269, and for the maximum we find λ5238. On account of the small dispersion, errors of a few angstroms are not excluded.

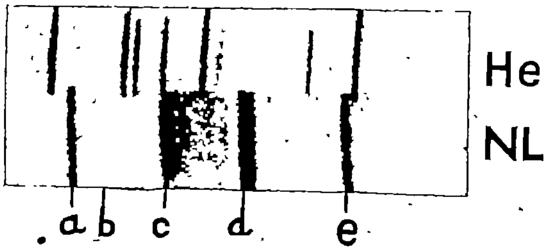

FIG. 1.

Comparing this result with those obtained for the luminescence from solid nitrogen, it is of interest to notice that when small quantities of solid nitrogen are condensed in a solid system of inert gases, we find one of the components of N_2, which in certain cases is dominant, to have wave-lengths of λλ5236-5239, *which within the limits of experimental errors correspond to the wave-length found for the maximum of the second green auroral line.* L. VEGARD.

Physical Institute, Oslo, Feb. 11.

Biological Fact and Theory.

PROF. JOHNSTONE'S letter in NATURE of Feb. 26 suggests an analogy. I happen for my sins to be gifted with very poor mathematical powers. Like him, also, on this account I "feel that I may be missing something that will help in an understanding" of the scientific problems with which mathematics are concerned. But I do *not* therefore attempt to belittle mathematical physics as Prof. Johnstone attempts to belittle the results of Mendelism.

He asks "what are the fundamentals of genetics?" The fundamentals of genetics to date are, I take it, the laws of segregation, independent assortment, and linkage; the proof that the chromosomes carry the genes, and that the genes are arranged in linear order; the genetical results of heteroploidy and chromosome aberrations; the individuality of the chromosomes (as, of course, complicated by crossing-over); the normal chromosomal determination of sex; the theory of genic balance; the facts concerning multiple allelomorphs, and multiple, modifying, and lethal factors; the new insight provided by neo-Mendelian methods into species-crosses and into the effects of inbreeding and cross-breeding; the origin of certain variations by point-mutation, chromosome-mutation, genome-change, deficiency, duplication, balanced lethals, and abnormal crossing-over; the demonstration that Mendelism and biometrics are not opposed; the fact that no development is possible at all in the absence of at least one haploid set of chromosomes; the demonstration that genes often determine the *rate* of definite developmental processes. There are doubtless other points which I have forgotten in this hasty survey; but it is absurd to imply that this is not a very considerable achievement and an "ample foundation" for future work.

Prof. Johnstone and Prof. Walker both seem to think that the sum of the genes *cannot* be responsible for the development of the "organism as a whole" or large characters such as the head. But has Liverpool never heard of Boveri's experiments on dispermic sea-urchin eggs, published exactly twenty years ago? It may be at present impossible to understand how the sum of the genes is responsible for the development of the organism as a whole, but Boveri made it reasonably certain that it is actually the case.

However, the work of the experimental embryologists, of Child, and of Goldschmidt, is at last beginning to give us an insight into the *how* of this problem—but only by building on the Mendelian foundation which Prof. Johnstone scorns. I would refer critics to Goldschmidt's new book ("Physiologische Theorie der Vererbung") and to a brief critical summary of my own (NATURE, Feb. 23, 1924) as showing how the obvious difficulties of the situation may perhaps be surmounted. I hope to summarise some of the recent work on the relations of hereditary constitution to developmental physiology in an article in NATURE in the near future. Meanwhile I would merely ask Prof. Johnstone whether he, like Prof. Noël Paton, wants to leave on one side all the results of Mendelian work in our attack upon the problem of heredity and its relation to the development of the organism as a whole? That is the only meaning I can attach to his concluding sentences; and it appears to me to be a counsel of despair.

Prof. Walker says (NATURE, Jan. 29, p. 161) that Dobell 'proved' that hereditary characters could not be controlled by chromosomes in certain Protozoa. The main reason advanced by Dobell concerned sex, and was that the Protozoa in question were haploid during all their sexually differentiated phase. If Prof. Walker had been better acquainted with genetical literature he would have remembered that almost simultaneously with Dobell's 'proof,' Wettstein was demonstrating experimentally, and conclusively, the control of sex by chromosomes in another group of organisms in which sex is displayed in the haploid phase—the mosses. Dobell's *a priori* arguments were never even theoretically valid, and long since fell to the ground on confrontation with actual fact.

As to Tornier:—If Prof. MacBride chooses to believe that experiments on developmental physiology, unaccompanied by breeding, have any direct bearing on heredity, I fear I cannot argue with him; to my mind, Tornier's work has just as much (or as little) bearing on the origin of mutations as has that of Driesch or Jenkinson or Child. For the information of readers of NATURE, however, it should be recorded that Berndt (*Zts. Ind. Abst. Vererb.*, 36, 1925) has repeated Tornier's goldfish work, and has also bred goldfish, on a large scale, and fails to verify either Tornier's facts or conclusions save in a few negligible details.

JULIAN S. HUXLEY.

King's College,
Strand, London, W.C.2, Feb. 22.

The Radcliffe Science Library, Oxford.

THE two paragraphs on pages 247-8 of NATURE of Feb. 12, 1927, in reference to the proposed transfer of the Radcliffe Science Library at Oxford to the University of Oxford, have been framed in such a way as to convey a false impression of the facts of the proposed arrangement. The Radcliffe Trustees would therefore be obliged if the following corrections could be inserted:

1. The trustees and the electors have refrained from appointing a successor to the late Dr. Jackson simply in view of the fact that very shortly after his death, negotiations for the proposed transfer were set on foot, pending which it would have been undesirable to make any fresh appointment.

2. In fact, the Library has been during the last few years most admirably carried on by the sub-librarian, Mr. James Ford, whose services the University has recently recognised by conferring on him the degree of M.A., *honoris causa*.

3. The second paragraph is a travesty of what is proposed. Had the writer, or the person who furnished the materials, candidly examined the print of the scheme of transfer which appeared in two numbers of the *Oxford University Gazette* (Feb. 2 and 9, 1927), he must have observed that all existing facilities and privileges of readers and students in the Radcliffe Science Library are preserved with meticulous care, including in particular 'the open shelf' and the right of taking books out into the various scientific departments of the University Museum.

4. In regard to the suggestions which both paragraphs make, that during these three years "the Library has lost many books by theft" (an inevitable source of loss which is in some degree common to all public libraries), the plain fact is that the annual proportion of such losses has fallen very much during the period in question: such books as have been so lost are current text-books of small pecuniary value, and their actual number is exceedingly small.

Cottesloe.
(Chairman of the Radcliffe Trustees.)

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1. Lord Cottesloe does not explain why the Radcliffe Trustees, in negotiating the transfer of scientific books to the University, would not have been greatly assisted if they had had the benefit of the inside scientific knowledge of their own Librarian. Their readers have been deprived of his expert aid for *three* years, and that is a long time in the history of a science library, or in the life of an undergraduate.

2. The merits of Mr. Ford and his invariable courtesy on trying occasions are recognised by all who use the Library; but he would be the last person to lay claim to that special knowledge of scientific literature for which generations of Radcliffe Librarians have been famous and helpful.

3. The past success of the Science Library has undoubtedly been partly due to the above-mentioned facilities, wisely given by former Librarians. It is exceedingly doubtful whether the proposed association with the Bodleian Library will lead to the improvement of those facilities. The experience of many a reader is that the difficulties of obtaining books from the Bodleian for use in the Radcliffe Library are so great as to be deterrent.

4. Complaints of undergraduates who, on the eve of examination, are deprived of text-books, even though "of small pecuniary value," evidently ring louder in the ears of their tutors than in those of the Radcliffe Trustees.

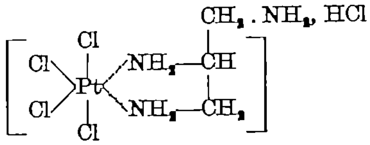
The Writer of the Notes.

A Novel Type of Optically Active Complex Metallic Salt.

Werner's conception of co-ordinated groups and of auxiliary valency has been extraordinarily useful in classifying and in elucidating the configurations of complex metallic compounds. Although many salts of this class, such as *tris*-ethylenediamine cobaltic chloride $[Co(NH_2.CH_2.CH_2.NH_2)_3]Cl_3$, have been resolved into optically active components, no proof has hitherto been given that an auxiliary valency linking can render a carbon atom asymmetric. This interesting proposition has been now established by the further study of the recently described salt, tetrachloro- (triaminopropane monohydrochloride)-platinum, $PtCl_4,NH_2.CH_2.CH(NH_2).CH_2.NH_2,HCl$, obtained by the action of the $\alpha\beta\gamma$-triaminopropane hydrochloride on chloroplatinic acid (Mann, *Jour. Chem. Soc.*, 129, 2681; 1926).

In the new salt the components, $PtCl_4$ and two of the NH_2-groups with some of the associated carbon and hydrogen atoms, must lie inside the co-ordinated group, whilst the third NH_2-group must protrude therefrom. It has now been found that the salt can be resolved into optically active components by the aid of silver *d*- and *l*-camphorsulphonate. The two salts, *l*-base *d*-acid, and *d*-base *l*-acid, have thus been obtained in an optically pure state; the hydrochlorides regenerated from these salts give molecular rotations of − 502° and + 501° respectively for the mercury green line in aqueous solution at 15°.

It is clear, therefore, that the constitution of the hydrochlorides must be represented by the following formula:



In the above formula the enantiomorphism of configuration is associated with asymmetry of the middle or β-carbon atom of the triaminopropane molecule; this asymmetry arises from the attachment of the α- and β-amino-groups to the platinum atom by auxiliary valencies. This is the first case to be recorded in which asymmetry of a carbon atom results from the operation of auxiliary valencies.

The new type of molecular enantiomorphism now disclosed will no doubt appear among numerous complex metallic compounds and, indeed, a complex copper salt, analogous in constitution to the above platinum salt, has been already prepared (*loc. cit.*). We are now engaged on the further investigation of these and other related compounds.

F. G. Mann.
W. J. Pope.

The Chemical Laboratory,
University of Cambridge, Feb. 7.

Migration and Reproductive Rhythm in Birds.

In a previous letter (Nature, April 4, 1925) a brief account was given of an attempt to break the annual reproductive rhythm in the Junco (*Junco hyemalis*) and to induce premature recrudescence of the gonads in the middle of the winter. It was suggested that migration might be dependent on the production of a hormone by the organs whilst in a certain stage of regeneration. Thanks to a research grant from the Royal Society, I have this winter been able to repeat and extend my earlier investigations. Nearly two hundred Juncos were trapped on their southward migration in the autumn and divided, as before, between two aviaries. The experimental one has been artificially lit since Oct. 1, beginning on the first day with 5 minutes after darkness, 10 on the second, 15 on the third, and so on. The controls got no artificial light. Their day was therefore decreasing, while that of the experimentals was increasing artificially at about the same rate as it would have been normally in the spring. Neither aviary is heated.

An experimental Junco was killed along with a control on Dec. 30, 1926, and dissected. In this experimental bird the testes were large and conspicuous and practically in the spring breeding condition. In the control the testes were found to be quite minute. The birds have been exposed to the severest winter weather on record in northern Alberta for at least the last twelve years, involving long spells with below-zero temperatures with a minimum of −35° F. Two canaries (one control, one experimental) which lived with the Juncos under identical conditions and were killed at the end of November 1926, possessed testes in precisely the same condition as those of the Juncos referred to above.

Juncos have been released at intervals. Out of 51 controls liberated between November and March (in two winters), 48 have been retaken alive at the point of liberation. Of the three remaining, one was killed by a cat, one by a shrike, and the last by a blizzard. In other words, it is evident that, regardless of temperature, barometric pressure, weather conditions in general, etc., birds released with their gonads at their resting minimum, stay where they are even though given their freedom hundreds of miles north of their normal wintering grounds. They will not migrate while in this condition.

Out of 36 experimentals released this winter after the first samples, taken at random from the aviary, showed the organs to be developing, 14 have been retaken. The other 22 departed upon release. All the ones retaken have been killed for examination. Without exception their gonads have been in the condition of one or other of the two Juncos referred to above. None with organs in an intermediate stage of development have stayed here upon release. Returns from liberated birds would probably be too much to hope for in the circumstances, but each is ringed with a U.S. Biological Survey band.

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Carbon Monoxide Poisoning in the Absence of Hæmoglobin.

Warburg (*Biochem. Zeit.*, 177, p. 471; 1926) has shown that carbon monoxide depresses the rate of oxygen consumption by yeasts and a micrococcus, and that the amount of carbon monoxide required to produce a given effect increases with the partial pressure of oxygen. He concluded that carbon monoxide competes with oxygen for a catalyst concerned in respiration, as it does for hæmoglobin in vertebrates. He also showed that the affinity of oxygen for this substance is 7-14 times that of carbon monoxide, instead of 1/150 to 1/550 as in the case of hæmoglobin at 15° C., and that, like carbon monoxide hæmoglobin, the compound formed with carbon monoxide is dissociated by light.

I have extended these observations to two higher organisms, namely, the wax-moth *Galleria mellonella* and the cress plant *Lepidium sativum*. The moths behave normally in so little as 2·0 per cent. oxygen at atmospheric pressure provided this gas is diluted with 'nitrogen,' but become motionless in 0·8 per cent. In intermediate concentrations they are feeble and ataxic. When, however, the oxygen is diluted with carbon monoxide, about 16 per cent. of an atmosphere of oxygen is needed for normal behaviour, and in 8·8 per cent. oxygen + 91 per cent. carbon monoxide they are completely immobile. With intermediate amounts of oxygen, smaller amounts of carbon monoxide are poisonous. On admitting air, recovery is rapid and complete.

Cress seeds would not germinate at all in atmospheres containing less than 1·7 per cent. oxygen when diluted with nitrogen, and even in 5 per cent. oxygen growth was poor, though it was almost normal in 10 per cent. When the oxygen was diluted with carbon monoxide there was no germination whatever under 3 per cent. oxygen, and only a few seeds opened in 7 per cent., while in 14 per cent. growth was slow. A comparison of different cultures showed that for a given amount of growth 2-3 times as much oxygen was needed in the presence of large quantities of carbon monoxide as in its absence. Carbon monoxide is therefore relatively less poisonous for cress than for moths or yeast.

The most probable conclusion from these experiments is that oxygen, before it can be utilised for some at least of the oxidative processes in the cell, must combine with a substance possessing a lesser but well-marked affinity for carbon monoxide, these two gases combining with the same group in its molecule. As this substance is found in higher animals and plants as well as bacteria and fungi, it is probably a nearly universal cell constituent. The apparently different ratio of its affinities for carbon monoxide and oxygen in cress as compared with yeast and moths, is of course paralleled in the case of hæmoglobins from different animals.

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Persistent Lines of Hafnium.

A number of spectra of zirconium ores and oxides have been examined for persistent lines of hafnium, using the wave-lengths for this latter element given by Hansen and Werner (Nature, 112, 618; 1923). The most persistent lines observed—three of which were found in all spectra examined—are at wave-lengths

2773·40, 2866·35, and 2919·55 angstroms,

of which the first is the most persistent. Other lines slightly less persistent are 2516·85, 2887·15, 2898·25, 2904·40, (2904·80), 2940·80, 2964·85, 3194·20. (The line 2904·80 is uncertain on account of a strong zirconium line nearby. The hafnium line and its neighbour 2904·40 are possibly a pair like those at 2513·00 and 2512·70. The line 2904·40 is very persistent, but the shorter pair are not.)

On account of the shortness of the range of Hansen and Werner's wave-lengths, none of these lines may safely be considered to be true *raies ultimes*, but their persistence may have some practical utility. In this regard it may be remarked that the crude ores are but slightly more difficult of examination than are fairly pure oxides, in spite of the richness of the preponderant spectra involved. With moderate dispersion ($\lambda\lambda$ 7000-2100 on a 10-inch plate) and good focus, the number of blends involving strong hafnium lines in the region studied is small and for analytical purposes probably of little moment. In using the ores and oxides of zirconium in a carbon arc, satisfactory spectra were not frequently obtained unless the arc carried enough current to be noisy. When satisfactory zirconium spectra were got there was no uncertainty about the hafnium traces, repeated exposures giving concordant results. Of the ores at hand the richest was of Wisconsin origin, being surpassed only by concentrates from a Carolina ore which was not available in crude state. In addition to the commoner elements in the ores, scandium appeared strongly in several cases.

Regularities in the spectrum of hafnium, to which the persistent lines should be a guide, have not yet appeared satisfactorily. The arc spectrum should be of odd multiplicity; McLennan, McLay, and Smith (*Proc. Roy. Soc. London*, 112, 76; 1926), applying Hund's principles, make the lowest arc term a triplet *F*. Inspection of Hansen and Werner's wave numbers beginning with the differences between the most persistent observed lines reveals a number of apparent triplets, and several triplet combinations having satisfactory intensities and the latter meeting possible inner quantum restrictions. Lacking confirmation such as Zeeman effect, these regularities seem, however, too conjectural to deserve recording at present.

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The Intrinsic Fields in Ferromagnetic Substances.

From many points of view it seems evident that the so-called 'molecular field' introduced by P. Weiss into the theory of ferromagnetism cannot be purely magnetic. The magnitude of such a field, if responsible for the ferromagnetic phenomena, would be of the order of 10^7 gauss (in the saturated state). On the other hand, a purely magnetic field of the same order of magnitude, as W. Voigt has pointed out, is required for accounting for the enormous Faraday- or Kerr-effect in ferromagnetic substances. The study of this effect in the infra-red part of the spectrum (where the classical theory of 'free' electrons in metals is fairly valid) seems to make it probable that the so-called 'free' electrons moving between the atoms of iron or nickel are influenced by intrinsic magnetic fields of the order of 10^7 gauss. Thus two independent sources seem to make probable the existence of such enormous magnetic fields. Since both methods are, however, more or less indirect, it seemed worth while to work out a direct experimental method which could give some information as to the fields existing inside a ferromagnetic substance.

As an instrument for studying the intrinsic fields, a narrow beam of real free electrons, β-particles, was chosen. If a magnetic field exists inside a magnetised foil of nickel, it is evident that the beam of β-particles passing through the foil will be deflected. The experimental arrangement was chosen in such a way that fields of the order of 10^4 gauss (that is, fields of the order of the induction actually existing) would remain unnoticed. But fields exceeding 10^5 gauss could be easily detected by the displacement of the traces of β-particles on a photographic plate. Nickel-foils of 0·015 mm.–0·022 mm. thickness were magnetised in fields of about 500 gauss and more.

No difference whatever was detected between photographs taken using magnetised and demagnetised nickel foil. Thus it can be claimed that no magnetic field exceeding 10^5 gauss exists in a ferromagnetic substance.

Further experiments on the passage and scattering of β-particles in ferromagnetic substances are in progress.

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Action of Magnetic Fields on the Refractive Index of Carbon Dioxide Gas.

In Nature of Nov. 20, 1926, p. 734, Messrs. Ghosh and Mahanti report an alteration of refractive index of carbon dioxide on applying a magnetic field of 3600 gauss transversely to the direction of propagation of the light. They attempt to explain this effect by an orientation of the molecules in the magnetic field. Now in a gas the molecules of which are orientated, if any effect on the refractive index were expected, one would naturally anticipate the primary effect would be a double refraction. Krishnan (*Proceedings of the Indian Association for the Cultivation of Science*, 10, 1. 35; 1926) has searched diligently for this effect in pure carbon dioxide over the whole range of pressures used by Ghosh and Mahanti, and his results were uniformly negative. For this reason an effect of the type described could not be due to molecular orientation. Further, the basis for the supposition of orientation in polyatomic gases, namely, the experiments of Glaser on their susceptibility, has been rendered very uncertain by Lehrer (*Ann. d. Physik*, 81, 229; 1926). Using a more satisfactory method, the latter was unable to reproduce Glaser's results. These facts made the experiments of Ghosh and Mahanti very difficult to understand, and it was considered worth while to repeat them.

Fields of 3600 and 6000 gauss were used. The carbon dioxide was prepared by heating pure sodium bicarbonate, and was dried by freezing and over phosphorus pentoxide. A Jamin refractometer was used, illuminated by the green line of mercury, $\lambda = 5461$. The compensating tube was evacuated; the other lay between the poles of an electromagnet. Carbon dioxide was admitted by a leak into the second tube, and at the same time the fringe shift was noted. In all sixty fringes passed the cross-wire for the range of pressure, 0-450 mm. mercury, as opposed to eight in the experiment of Ghosh and Mahanti. On plotting pressure against fringe-shift the same straight line was obtained whether the field was on or off, and on reduction the refractivity agreed to within one-half per cent. with the tabulated value. In fact, the results seem quite inconsistent with the parabolic curve of Ghosh and Mahanti.

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Magnetic Induction in Continuous Media.

Consider a volume τ of any shape, occupied by material of unit permeability, having resistivity ρ (e.m.u.) placed in an alternating magnetic field of arbitrary distribution, sinusoidal in time, with pulsatance p. Let L specify its leading dimension. The three parameters which, together with the applied field distribution, determine the heat generated and the power dynamically conserved in the volume τ, are L, ρ, p. Then if H (e.m.u.) denotes the amplitude of the magnetic field at a particular point, the heat generated can be written

$$H^2 . L^\alpha p^\beta \rho^\gamma f\left(\frac{L^2 p}{\rho}\right) \text{ erg./sec.}^{-1},$$

where the function f depends, *inter alia*, on the distribution of H. It is supposed that the greatest dimension of the volume τ is short compared with $\frac{2\pi c}{p}$.

The argument of f is in effect the only possible adimensional combination of the parameters.

Then $L^\alpha p^\beta \rho^\gamma$ must have dimensions $L^3 T^{-1}$, and may therefore be written $L\rho(L^2 p/\rho)^\beta$ where β is arbitrary. If then we vary any two of the parameters, so as to keep $L^2 p/\rho$ constant, the power dissipated will vary as $L\rho$, $L^2 p$, $\rho\sqrt{\rho/p}$ according to the variables chosen, while for a complete variation, subject only to the above restriction, the power remains proportional to $L^2\sqrt{\rho p}$.

Variation of L has been supposed to take place by a variation of the scale of the space of τ and the field H. Variation of the power dynamically conserved obviously follows the same rules as the power dissipated.

Apparently this principle of similitude has not previously been formally enunciated.

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Physical Aspects of Quantum Mechanics.[1]

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THE purpose of this communication is not to give a report on the present status of quantum mechanics. Such a report has recently been published by W. Heisenberg, the founder of the new theory (*Die Naturwissenschaften*, **45**, 989, 1926). Here we shall make an attempt to understand the physical significance of the quantum theoretical formulæ.

At present we have a surprisingly serviceable and adaptable apparatus for the solution of quantum theoretical problems. We must insist here that the different formulations, the matrix theory, Dirac's non-commutative algebra, Schrödinger's partial differential equations, are mathematically equivalent to each other, and form, as a whole, a single theory. This theory enables us to compute the stationary states of atoms and the corresponding radiation, if we neglect the reaction of the radiation on the atoms; it would seem that in this respect we have nothing more to wish for, since the result of every example in which the calculations are carried out agrees with experiment.

This question, however, of the possible states of matter does not exhaust the field of physical problems. Perhaps more important still is the question of the course of the phenomena that occurs when equilibrium is disturbed. Classical physics was entirely concerned with this question, as it was almost powerless toward the problem of structure. Conversely, the question of the course of phenomena had practically disappeared from the quantum mechanics, because it did not immediately fit into the formal developments of the theory. Here we shall consider some attempts to treat this problem on the new mechanics.

In classical dynamics the knowledge of the state of a closed system (the position and velocity of all its particles) at any instant determines unambiguously the future motion of the system; that is the form that the principle of causality takes in physics. Mathematically, this is expressed by the fact that physical quantities satisfy differential equations of a certain type. But besides these causal laws, classical physics always made use of certain statistical considerations. As a matter of fact, the occurrence of probabilities was justified by the fact that the initial state was never exactly known; so long as this was the case, statistical methods might be, more or less provisionally, adopted.

The elementary theory of probability starts with the assumption that one may with reason consider certain cases equally probable, and derives from this the probability of complicated combinations of these. More generally: starting with an assumed distribution (for example, a uniform one, with equally probable cases) a dependent distribution is derived. The case in which the derived distribution is entirely or partly independent of the assumed initial distribution is naturally particularly important.

The physical procedure corresponds to this: we make an assumption about the initial distribution, if possible, one about equally probable cases, and we then try to show that our initial distribution is irrelevant for the final, observable, results. We see both parts of this procedure in statistical mechanics: we divide the phase space into equally probable cells, guided only by certain general theorems (conservation of energy, Liouville's theorem); at the same time we try to translate the resulting space-distribution into a distribution in *time*. But the ergodic hypothesis, which was to effect this translation, and states that every system if left to itself covers in time its phase space uniformly, is a pure hypothesis and is likely to remain one. It thus seems that the justification of the choice of equally probable cases by dividing the phase space into cells can only be derived *a posteriori* from its success in explaining the observed phenomena.

We have a similar situation in all cases where considerations of probability are used in physics. Let us take as an example an atomic collision—the collision of an electron with an atom. If the kinetic energy of the electron is less than the first excitation potential of the atom the collision is elastic: the electron loses no energy. We can then ask in what direction the electron is deflected by the collision. The classical theory regards each such collision as causally determined. If one knew the exact position and velocity of all the electrons in the atom and of the colliding electron, one could compute the deflexion in advance. But unfortunately we again lack this information about the details of the system; we have again to be satisfied with averages. It is usually forgotten that in order to obtain these, we have to make an assumption about equally probable configurations. This we do in the most 'natural' way by expressing the co-ordinates of the electron in its initial path (relative to the nucleus) in terms of angle variables and phases, and by treating equal phase intervals as equally probable. But this is only an assumption, and can only be justified by its results.

The peculiarity of this procedure is that the microscopic co-ordinates are only introduced to keep the individual phenomena at least theoretically determinate. For practical purposes they do not exist: the experimentalist only counts the number of particles deflected through a given angle, without bothering about the details of the path; the essential part of the path, in which the reaction of the atom on the electron occurs, is not open to observation. But from such numerical data we can draw conclusions about the mechanism of the collision. A famous example of this is the work of Rutherford on the dispersion of α-particles; here, however, the microscopic co-ordinates are not electronic phases, but the distance of the nucleus from the original path of the α-particle. From the statistics of the dispersion; Rutherford could prove the validity of Coulomb's law for the reaction between the nucleus and the α-particle. The microscopic co-ordinate had been eliminated from the theoretical formula for the distribution of the particles over different angles of deflexion.

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[1] Extension of a paper read before Section A (Mathematics and Physics) of the British Association at Oxford on Aug 10, 1926. Translated by Mr. Robert Oppenheimer. The author is very much obliged to Mr. Oppenheimer for his careful translation.

We thus have an example of the evaluation of a field of force by counting, by statistical methods, and not by the measurement of an acceleration and Newton's second law.

This method is fundamentally like that which makes us suspect that a die is false if one face keeps turning up much more often than every sixth throw; statistical considerations indicate a torque. Another example of this is the 'barometer formula.' Of course, we can derive this dynamically, if we regard the air as a continuum and require equilibrium between hydro-dynamical pressure and gravity; but actually pressure is only defined statistically as the average transport of momentum in the collisions of the molecules, and it is therefore not merely permissible but also fundamentally more sound to regard the barometer formula as a counting of the molecules in a gravitational field, from which the laws of the field may be derived.

These considerations were to lead us to the idea that we could replace the Newtonian definition of force by a statistical one. Just as in classical mechanics we concluded that there was no external force acting if the motion of the particle was rectilinear, so here we should do so if an assembly of particles was uniformly distributed over a range. (The choice of suitable co-ordinates leads to similar problems on both theories.) The magnitude of a force, classically measured by the acceleration of a particle, would here be measured by the inhomogeneity of an assembly of particles.

In the classical theory we are of course faced with the problem of reducing the two definitions of force to one, and that is the object of all attempts at a rational foundation of statistical mechanics; we have tried to make clear, though, that these have not been altogether successful, because in the end the choice of equally probable cases cannot be avoided.

With this preparation we turn our attention to quantum mechanics. It is notable that here, even historically, the concept of *a priori* probability has played a part that could not be thrown back on equally probable cases, for example, in the transition-probabilities for emission. Of course this might be merely a weakness of the theory.

It is more important that formal quantum mechanics obviously provides no means for the determination of the position of particles in space and time. One might object that according to Schrödinger a particle cannot have any sharply defined position, since it is only a group of waves with vague limits; but I should like to leave aside this notion of 'wave-packets,' which has not, and probably cannot be, carried through. For Schrödinger's waves move not in ordinary space but in configuration space, that has as many dimensions as the degrees of freedom of the system ($3N$ for N particles). The quantum theoretical description of the system contains certain declarations about the energy, the momenta, the angular momenta of the system; but it does not answer, or at least only answers in the limiting case of classical mechanics, the question of where a certain particle is at a given time. In this respect the quantum theory is in agreement with the experimentalists, for whom microscopic co-ordinates are also out of reach, and who therefore only count instances and indulge in statistics. This suggests that quantum mechanics similarly only answers properly put statistical questions, and says nothing about the course of individual phenomena. It would then be a singular fusion of mechanics and statistics.

According to this, we should have to connect with the wave-equations such a picture as this: the waves satisfying this equation do not represent the motion of particles of matter at all; they only determine the possible motions, or rather states, of the matter. Matter can always be visualised as consisting of point masses (electrons, protons), but in many cases the particles are not to be identified as individuals, *e.g.* when these form an atomic system. Such an atomic system has a discrete set of states; but it also has a continuous range of them, and these have the remarkable property that in them a disturbance is propagated along a path away from the atom, and with finite velocity, just as if a particle were being thrown out. This fact justifies, even demands, the existence of particles, although this cannot, in some cases as we have said, be taken too literally. There are electromagnetic forces between these particles (we neglect for the moment the finite velocity of propagation); they are, so far as we know, given by classical electrodynamics in terms of the positions of the particles (for example, a Coulomb attraction). But these forces do not, as they did classically, cause accelerations of the particles; they have no direct bearing on the motion of the particles. As intermediary there is the wave field: the forces determine the vibrations of a certain function ψ that depends on the positions of all the particles (a function in configuration space), and determine them because the coefficients of the differential equation for ψ involve the forces themselves.

A knowledge of ψ enables us to follow the course of a physical process in so far as it is quantum mechanically determinate: not in a causal sense, but in a statistical one. Every process consists of elementary processes, which we are accustomed to call transitions or jumps; the jump itself seems to defy all attempts to visualise it, and only its result can be ascertained. This result is, that after the jump, the system is in a different quantum state. The function ψ determines these transitions in the following way: every state of the system corresponds to a particular characteristic solution, an ***Eigenfunktion***, of the differential equation; for example, the normal state the function ψ_1, the next state ψ_2, etc. For simplicity we assume that the system was originally in the normal state; after the occurrence of an elementary process the solution has been transformed into one of the form

$$\psi = c_1 \psi_1 + c_2 \psi_2 + c_3 \psi_3 \ldots ,$$

which represents a superposition of a number of ***eigenfunktions*** with definite amplitudes c_1, c_2, c_3, . . . Then the squares of the amplitudes c_1^2, c_2^2 . . . , give the probability that after the jump the system is in the 1, 2, 3, state. Thus c_1^2 is the probability that in spite of the perturbation the system remains in the normal state, c_2^2 the probability that it has jumped to the second, and so on.[2] These probabilities are thus dynamically determined. But what the system actually does is not determined, at least not by the laws that are at present known. But this is nothing new, for we saw above that the classical theory—for example, for the collision problem—only gave probabilities. The classical theory introduces the microscopic co-ordinates which determine the individual process, only to eliminate them because of ignorance by averaging over their values; whereas the new theory gets the same results without introducing them at all. Of course, it is not forbidden to believe in the existence of these co-ordinates; but they will only be of physical significance when methods have been devised for their experimental observation.

This is not the place to consider the associated philosophical problems; we shall only sketch the point of view which is forced upon us by the whole of physical evidence. We free forces of their classical duty of determining directly the motion of particles and allow them instead to determine the probability of states. Whereas before it was our purpose to make these two definitions of force equivalent, this problem has now no longer, strictly speaking, any sense. The only question is why the classical definition is so useful for a large class of phenomena. As always in such cases, the answer is: Because the classical theory is a limiting case of the new one. Actually, it is usually the 'adiabatic' case with which we have to do: *i.e.* the limiting case where the external force (or the reaction of the parts of the system on each other) acts very slowly. In this case, to a very high approximation

$$c_1^2 = 1,\ c_2^2 = 0,\ c_3^2 = 0 \ldots ,$$

that is, there is no probability for a transition, and the system is in the initial state again after the cessation of the perturbation. Such a slow perturbation is therefore reversible, as it is classically. One can extend this to the case where the final system is really under different conditions from the initial one; *i.e.* where the state has changed adiabatically, without transition. That is the limiting case with which classical mechanics is concerned.

It is, of course, still an open question whether these conceptions can in all cases be preserved. The problem of collisions was with their help given a quantum mechanical formulation; and the result is qualitatively in full agreement with experiment. We have here a precise interpretation of just those observations which may be regarded as the most immediate proof of the quantised structure of energy, namely, the critical potentials, that were first observed by Franck and Hertz. This abrupt occurrence of excited states with increasing electronic velocity of the colliding electron follows directly out of the theory. The theory, moreover, yields general formulæ for the distribution of electrons over the different angles of deflexion, that differ in a characteristic way from the results that we should have expected classically. This was first pointed out by W. Elsasser (*Die Naturwissenschaften*, **13**, 711, 1925) before the development of the general theory. He started with de Broglie's idea that the motion of particles is accompanied by waves, the frequency and wave-length of which is determined by the energy and momentum of the particle. Elsasser computed the wave-length for slow electrons, and found it to be of the order of 10^{-8} cm., which is just the range of atomic diameters. From this he concluded that the collision of an electron with an atom should give rise to a diffraction of the de Broglie waves, rather like that of light which is scattered by small particles. The fluctuation of the intensities in different directions would then represent the irregularities in the distribution of the deflected electrons. Indications of such an effect are given by the experiments of Davisson and Kunsmann (*Phys. Rev.*, **22**, 243, 1923), on the reflection of electrons from metallic surfaces. A complete verification of this radical hypothesis is furnished by Dymond's experiments on the collisions of electrons in helium (Nature, June 13, 1925, p. 910).

Unfortunately, the present state of quantum mechanics only allows a qualitative description of these phenomena; for a complete account of them the solution of the problem of the helium atom would be necessary. It therefore seems particularly important to explain the above-mentioned experiments of Rutherford and his co-workers on the dispersion of α-particles; for in this case we have to do with a simple and completely known mechanism, the 'diffraction' of two charged particles by each other. The classical formula which Rutherford derived from a consideration of the hyperbolic orbits of the particles, is experimentally verified for a large range; but recently Blackett has found departures from this law in the encounters between α-particles and light atoms, and has suggested that these might also be ascribed to diffraction effects of the de Broglie waves. At present only the preliminary question is settled, of whether the classical formula can be derived as a limiting case of quantum mechanics. G. Wentzel (*Zeit. f. Phys.*, **40**, 590, 1926) has shown that this is in fact the case. The author of this communication has, furthermore, carried through the computation for the collision of electrons on the hydrogen atom, and arrived at formulæ which represent simultaneously the collisions of particles of arbitrary energy (from slow electrons to fast α-particles). As yet this has only been carried out for the first approximation, and so gives no account of the more detailed diffraction effects. This calculation thus yields a single expression for the Rutherford deflexion formula and the cross section of the hydrogen atom for electrons in the range studied explicitly by Lenard. The same method leads to a calculation of the probability of excitation of the H-atom by electronic collision, but the calculations have not yet been completed.

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[2] We may point out that this theory is not equivalent to that of Bohr, Kramers, Slater. In the latter the conservation of energy and momentum are purely statistical laws; on the quantum theory their exact validity follows from the fundamental equations. Statistical considerations only apply to quantities, like the angles of deflexion in a collision, which could not be quantised on the Bohr theory of angle variables.

It would be decisive for the theory if it should prove possible to carry the approximation further, and to see whether it furnishes an explanation of the departures from the Rutherford formula.

Even, however, if these conceptions stand the experimental test, it does not mean that they are in any sense final. Even now we can say that they depend too much on the usual notion of space and time. The formal quantum theory is much more flexible, and susceptible of much more general interpretations. It is possible, for example, to mix up co-ordinates and momenta by canonical transformations, and so to arrive at formally quite different systems, with quite different wave functions ψ. But the fundamental idea of waves of probability will probably persist in one form or another.[3]

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[3] Compare the article of Dr. P. Jordan, "Philosophical Foundations of Quantum Theory," to appear in a later issue of NATURE.

Benedictus de Spinoza.

By Prof. G. DAWES HICKS.

FIFTY years ago a memorable gathering of distinguished men assembled at The Hague, under the presidency of Prince Alexander of the Netherlands, on the occasion of the two-hundredth anniversary of Spinoza's death. They met in a building which was only a few yards away from the house in the Paviljonensgracht where the philosopher had spent the last few years of his life, and where on Feb. 21, 1677, he died. The principal speaker at that gathering was Ernest Renan; and, having in mind the monument about to be erected, and referring to the humble dwelling hard by, Renan exclaimed: "From his granite pedestal Spinoza will teach us all to follow the way which he found to happiness, and, centuries hence, men of learning, crossing the Paviljonensgracht, will say to themselves, 'It is perhaps from this spot that God was most nearly seen.'" The statue was finished in 1880; and now, on the two-hundred-and-fiftieth anniversary of Spinoza's death, it is proposed to complete the memorial by acquiring the house, to be called the *Domus Spinozana*, and equipping it as a home for research and as a meeting-place for scientific workers of various nationalities. It will be a fitting tribute to one of the world's greatest minds.

The story of this lonely thinker's life has frequently been told. Born at Amsterdam, whither his father had migrated from Portugal about thirty years previously, on Nov. 24, 1632, he spent the whole of his days in Holland. His mother died when he was barely six years old, and his father when he was twenty-two. Two years after his father's death he was excommunicated by the Rabbis; and from that period onwards he lived in modest lodgings, supporting himself at first partly by teaching and partly by grinding lenses for spectacles and optical instruments, in which latter occupation he persevered to the end. Until 1660 he remained in Amsterdam, where he became the leading spirit of a small circle of friends, who after his departure met periodically to discuss philosophical papers which he sent to them. From 1660 until 1663 he resided in Rhynsberg, near Leyden, and there he wrote the "De Intellectus Emendatione," part of his exposition of Descartes' "Principia" with the appendix, "Cogitata Metaphysica," and perhaps a portion of the "Ethics." In 1663 he removed to Voorburg, near The Hague, and stayed there until 1670. At Voorburg he was at first occupied with the "Ethics," but laid it aside in order to devote himself to the "Tractatus Theologico-Politicus," which seemed to him to be the more urgently needed, and which was published anonymously in 1670. In 1670 he removed to The Hague, where he remained until his death in 1677. Here he finished the "Ethics" and wrote the unfinished "Tractatus Politicus," both of which were published in the "Opera Posthuma," that appeared before the end of the year 1677. Nearly two centuries later there was discovered and published the Dutch text of a work of Spinoza's which appears to have been called "Tractatus de Deo et homine ejusque felicitate," written about the year 1660.

At the beginning of the treatise "De Intellectus Emendatione," Spinoza relates the circumstances that led him to devote himself to philosophical inquiry. The ordinary objects of human pursuit —sensuous enjoyment, wealth, station—had all evinced themselves, even when attained, as incapable of yielding real and lasting happiness. The reason seemed to him to be due to the fact that, while these objects are invariably transitory and fleeting in character, in making them ultimate ends men take them to be permanent and self-sufficing. True blessedness (*beatitudo*) could come only from being in possession of a changeless and abiding object of love, and there is, he was assured, no way of obtaining that possession save by knowing things as they actually are. For it was because in everyday experience our apprehension of things is fragmentary and piecemeal, because we contemplate them in isolation and from a limited point of view, that we are misled into desiring some of them as though they could constitute for us the supreme ends of life.

Scientific knowledge would, on the other hand, reveal the interconnexion of finite events, their dependence upon each other, and upon reality as a whole. The Whole alone could be perfect and eternal; and love of it could alone satisfy the soul's yearning. But the soul can only love what it knows; in order to be in harmony with the Whole, the mind of man must gain a more or less clear insight into its nature. To have a conception of the Whole would amount to having a conception of the eternal and necessary order of the universe; and, since "we needs must love the highest when we see it," would mean the attainment, on our part, of full and complete satisfaction of desire. It was, then, because he was convinced that knowledge is the way to blessedness, that Spinoza set forth upon the intellectual quest, and did not touch the problems of ethics until he had first sought to unravel the general structure of reality.

Spinoza's philosophy takes its start from the fundamental distinction between 'substantial' or self-dependent being and 'modal' or dependent being,—the distinction, in other words, between that which is 'in itself' (*in se*) and is conceived 'through itself' (*per se*) and that which is 'in another' (*in alio*) and is conceived through that other (*per quod etiam*). It had been, indeed, a cardinal principle of the Aristotelian philosophy that what Aristotle called primary substance was marked off from other kinds of being in virtue of the fact that in a proposition it could only stand as the subject, and never as the predicate, or as the quality of anything else. But, in Aristotle's view, finite individual entities were substances in this sense, whereas Spinoza's contention is that, when we have regard to its antecedents, there is no finite individual entity that does not forfeit its supposed substantive character and turn out to be itself predicable as a phase or modification of something else. Consequently, there can be but one self-dependent Being or Substance, namely, Reality, in its absolute entirety and completeness. What we take to be independent, substantive entities, whether physical or mental, must ultimately evince themselves as derivative 'modes' or states of the one absolute Being, ways in which that one absolute Being expresses or manifests itself.

The originality of Spinoza's thought comes strikingly to light in his determined and resolute effort to work out this conception. Substance, as that which is self-dependent, as *causa sui*, or the Unconditioned, must, he argued, be conceived as necessarily existing; in regard to it, that is to say, the question of origin or genesis cannot be raised. The existence of one finite event may legitimately enough be accounted for as the effect of another finite event, and that again as the effect of another, and so on in a never-ending series. But Substance is not an event, not even one colossal event, overlapping all others. It is that which must be presupposed in order that happenings or events should be at all. There can only be a coming-to-be *within* the realm of being. Accordingly, whoever admits the existence of any event, even that of his own act of thinking, is bound to admit the existence of that without which the existence of events would be inconceivable; and, since coming to be and ceasing to be form no part of the content of the Self-existent, this means that Substance must be 'eternal,' *i.e.* timeless, in character, that the Self-existent must be regarded as an eternal truth, which cannot be explained in terms of time or duration, even though that duration be thought of as unbounded in both directions.

Further, from the notion of the Self-existence there follows that of the infinitude of Substance. For as self-existent, Substance must, so Spinoza argues, be unique, and its uniqueness would be destroyed were it limited or restricted by other Self-existents. Just, however, as the term 'eternity' does not properly mean endless duration, so the term 'infinity' does not properly mean endless extent. Substance is infinite in the sense of being the self-contained, the self-complete; its infinity is involved, that is to say, in its unconditioned nature. So, too, Substance is one or a unity, not however in the numerical sense of being a member, even the single member, of a class, but in a sense in which ideas of number are inapplicable. Once more, Substance as complete, is perfection, yet again not in any sense that would imply the gradual realisation of a plan, the unfolding of something not yet actual, but in the sense that it is throughout all that it has in it to be.

Lastly, Substance is the cause of all things, and, indeed, ultimately the only cause. Still, the term 'cause' carries with it, in this context, no implication of producing or creating. To say that Substance is the cause of all things is to say that all things flow from the nature of Substance with the same timeless necessity as the equality of its three angles to two right angles follows from the nature of a triangle. By the term 'cause,' when used in reference to Substance, Spinoza understood, that is to say, logical ground or reason. As a logical ground involves its consequents, so the consequents of the supreme ground are not to be thought of as independent of it but as implicated essentially in it.

The supreme ground, thus conceived, is called by Spinoza indifferently 'Substance,' or 'Nature,' or 'God'; and by each of these terms he means simply Being in its fullness and completeness, that which comprises within its indivisible unity all the positive characteristics in which reality is expressed. What, in fact, he was concerned to maintain was that the notions which we apply legitimately enough to parts of the universe—notions of temporal sequence, change, producing cause, evolution, and so on—become unintelligible and meaningless when applied to the universe as a whole. To speak, for example, of 'cosmic evolution,' if by that be intended the evolution of the totality of things, is, he would have urged, a contradiction in terms. For evolution implies not only that which is evolving, but also an environment with which it is in interaction, and obviously there can be no environment of the totality of things. Not only so. Whoever pictures the universe in its entirety as evolving must inevitably be pulled up before the *impasse* of a first beginning. He would have to start with something, such, for example, as Herbert Spencer's 'indefinite, unstable homogeneity,' that 'once upon a time' appeared upon the stage of being. But, in that case, the philosophic problem centres precisely there; and so long as the 'something' remains unaccounted for, not a step has been taken towards the solution of that problem. Against all such ways of regarding the system of things, Spinoza insists upon conceiving it as an organic Whole, consisting of unconditioned and conditioned, of supreme ground and dependent consequents.

With this conception of God, or the Absolute, Spinoza had evidently left the somewhat halting conclusion of Descartes and the Cartesians a long way behind. It was no longer possible to ascribe to material things on one hand, and to minds on the other, the separate and independent existence which these thinkers had claimed for them. Material things and minds could be no other than 'modes,' phases, states (*affectiones*) of the one ultimate Reality. If, now, we proceed to inquire how the modes are related to one another and to Substance, we come upon the notion of 'Attribute,' concerning the significance of which much difference of opinion prevails. One interpretation, at any rate, it seems to me, merits unreserved rejection. Spinoza could not have meant that the Attributes are real forces or kinds of energy (*Urkräfte*, as Kuno Fischer has it) of which God or Substance is the bearer. For that would have been palpably inconsistent with wellnigh everything he had laid down with respect to the nature of Substance. What could one make, for example, of the 'eternity' of Substance (in which "there is no *when*, no *before*, and no *after*") were one to conceive of its essence as being constituted by potencies or powers of this description? And how, again, could the unity of Substance be retained, if its essence is to be thought of as made up of various kinds of energy—physical, mental, and possibly many others—operating along distinct, though parallel, lines of activity? If Substance be prior to and more universal than these streams of energy, then the latter would become, according to Spinoza's definitions, 'modes,' for each would have something in common with the others, and could not, therefore, be conceived through itself and in itself, in such a way that its conception did not involve the conception of anything else. If, on the other hand, Substance be not more universal than the Attributes, then, on the interpretation in question, it would inevitably resolve itself into a plurality of independent powers, which could only be externally connected.

No doubt any interpretation of Spinoza's meaning is exposed to criticism, but probably Sir Frederick Pollock's suggestion that the Attributes were intended to be taken as 'aspects' of Substance is most nearly in accord with the statement that "Attribute is what intellect apprehends of Substance as constituting its essence." As has often been pointed out, this statement implies by no means that the Attributes are merely our subjective ways of conceiving Substance. For that which is grasped by the 'intellect' (as contrasted with 'imagination') would be, according to Spinoza, objectively real. What, then, I take him to mean, is that there are not two realms, a realm of Extension and a realm of Consciousness, but that it is one and the same reality which manifests both aspects, that everything extended is at once also conscious, and everything conscious is at once also extended. All *res particulares* are, that is to say, regarded from one point of view, modes of Extension, and, regarded from another point of view, modes of Consciousness; all are, as he expresses it, *animata*, although in different degrees.

It is perfectly true that in tracing the descent from the Unconditioned to the Conditioned the idea of agency has at some stage to be introduced, and equally certain that then the crucial difficulties of Spinoza's philosophy are full upon us. Adopting a familiar device, Spinoza endeavoured to effect the passage from the infinite to the finite, from *Natura Naturans* (Nature as ground) to *Natura Naturata* (Nature as consequent, or as a system of modes), by inserting a number of intermediary terms in order to bridge the gap. He introduced, in fact, two grades or classes of what he called 'infinite modes'; first, those which follow immediately from the Attributes, and secondly, those which follow from the Attributes when already modified. On the side of Extension, motion and rest, on the side of Consciousness, the absolutely infinite intellect, are the immediate infinite modes, while the mediate infinite mode on the side of Extension is 'the form of the whole universe' (*facies totius universi*), that on the side of Consciousness not being named. Under cover of these intermediaries the element of activity enters full fledged upon the scene, though how it is supposed to emerge is veiled, it must be confessed, in obscurity. Motion follows, we are told, directly from extension. But does it? Motion may no doubt be said to depend upon extension, but in what sense can it be said to follow from it? If extension be extension simply, it cannot give rise to what is more than itself. Nor would the difficulty be surmounted by identifying extension with physical energy, for physical energy already involves motion, and there would be, in that case, no transition from Attribute to infinite mode.

The attempt not only to conceive an ultimate unity in which all determinate existents have their ground, but likewise to work out logically the conception, was, indeed, a tremendous undertaking, and Spinoza's philosophy will always stand as one of the most sustained efforts in the history of human thought to solve its deepest problem. No one would be concerned to claim that he actually accomplished the whole task which he prescribed for himself. Few would now, I take it, venture to dispute the judgment that in the long run the modal system and the supreme ground fail to come together in one coherent view, that the temporal existence of modes obstinately refuses to fit into the timeless being of Substance. On one hand, it is contended that all things which follow from the absolute nature of any Attribute of Substance must exist eternally and be infinite, and that that which is finite and has a determinate existence can not be produced by the absolute nature of any such Attribute. On the other hand, it is maintained that a determinate existent thing cannot be determined to exist or to act, unless it be so determined by another cause which is also finite and has a determinate existence, and so on *ad infinitum*. That is to say, a determinate existent thing has a positive reality in so far as it expresses the eternal essence of Substance, but in so far as it is finite, in so far as it is limited and restricted, it has not. Yet it is precisely in this latter capacity that modes function as causes in the modal sphere, and thus serve to account for the existence of each other. Modal existence has to be recognised as a fact, though it falls apart from substantial existence, and the chasm widens as the character of the former comes to be more closely scrutinised. But criticism is comparatively easy, constructive thinking is difficult. When criticism has in this connexion said its last word, there will remain in Spinoza's constructive achievement amply sufficient to entitle him to the lasting gratitude of those who in his spirit strive to carry on the work of philosophical inquiry.

Obituary.

Mr. J. J. Lister, F.R.S.

With the death of J. J. Lister on Feb. 5 in his home at Grantchester, there passes away one of the band of younger zoologists who, under the leadership of Francis Maitland Balfour, helped to build up the reputation of the Cambridge school of zoology. Although he was most widely known for his important researches on the morphology and reproduction of the Foraminifera, he was a man of liberal interests in many branches of zoology and a keen and accomplished naturalist. Those of us who were his friends and colleagues in the 'eighties vividly remember not only his charm of manner but also the bright and stimulating conversation with which he enlivened our social meetings. There seemed to be few subjects within the wide range of natural history about which he had not something interesting to say. At the same time he was to the undergraduates of his generation a hero in the athletic world. As stroke of the first boat of the Lady Margaret Boat Club from 1878 until 1882, he led his men to many victories both on the Cam and at Henley, and later he was often seen on the river as stroke of the "Ancient Mariners."

Born at Leytonstone in 1857, Lister was the son of Mr. Arthur Lister, who was himself a fellow of the Royal Society and brother of Lord Lister. From an early period of his life, therefore, he must have been associated with men of scientific tastes and initiated into some of the mysteries of biological problems. His father was an authority on the Mycetozoa and published many important papers on this group of organisms. J. J. Lister and his sister took part in these investigations and added materially to the common stock of knowledge that the family possessed. It was not surprising, therefore, that when he wrote the article on Mycetozoa for Lankester's "Treatise on Zoology," it was rightly appraised as the most authoritative summary of our knowledge of the group in the language. But Lister was destined to achieve great personal fame for his work on another group of protozoa. The dimorphism of the species of Foraminifera was already known, but Lister showed, by the most careful investigations of the Polystomella of our own seas, that the two forms are not male and female respectively as had been suggested, but that each produces free swimming spores and that the spores of one of them may be sexual spores, although he failed to prove that the process of conjugation actually took place. His researches on Orbitolites, Quinqueloculina, Polytrema, and other Foraminifera also produced valuable additions to our knowledge of the group.

After taking his degree Lister entered St. Bartholomew's Hospital with the intention of entering the medical profession, but owing to ill-health he abandoned the idea and travelled for some years, first in a sailing ship to Australia and afterwards in H.M.S. *Egeria* in the Pacific Ocean. During this voyage in the surveying sloop, when he had the opportunity of visiting several remote and interesting islands, his ability as an accomplished man of science showed itself in the records of several important observations he made on various subjects. A short paper on the birds of Phœnix Island, in which he described the nesting habits of the frigate birds; an account of the natives of Bowditch Island; and the important conclusion he reached by his study of the islands of the Tonga Group, that, contrary to the Darwinian hypothesis of subsidence, coral reefs and atolls are formed in some regions where the land is undergoing elevation, were some of the varied contributions to knowledge that resulted.

Among the collections he brought home were some specimens of the coral Millepora beautifully preserved in spirit with the zooids expanded, and these he most generously handed over to the writer of this article for further study. They are undoubtedly the only specimens in which the expanded zooids have been seen in Great Britain, for in all the other material that has been collected the zooids are so tightly contracted as to be useless for demonstration purposes. He also brought back some specimens of the young stalked form of the coral Fungia, described by Stutchbury in 1830, and wrote a paper on the strobilisation of the genus.

During the later years of his life, long and continuous ill-health led to a retired life in his home in Grantchester, and his visits to the University Museum and Laboratory became more and more infrequent. But his interest in natural history never waned, and he devoted his energies to a searching investigation of variation in British Lepidoptera.

Lister was made a fellow of his College (St. John's) in 1899, and elected to the fellowship of the Royal Society in 1900. He was president of Section D of the British Association at the York meeting in 1906, and for many years an active member of the council of the Marine Biological Association.

S. J. H.

Prof. E. H. Rennie.

Dr. E. H. Rennie, whose death in South Australia was recently announced, was for more than forty years professor of chemistry in the University of Adelaide. Born on Aug. 19, 1852, he was the son of E. A. Rennie, Auditor-General of New South Wales, and grandson of James Rennie, who was professor of zoology at King's College, London, 1830–1834. His school days were spent in Sydney, and he graduated at the University of Sydney in 1870. For a few years he taught in the Sydney and Brisbane Grammar Schools, and in 1877 came to London to study chemistry. He obtained his doctor's degree in the University of London in 1881. While in London he was assistant for two years to Dr. C. R. Alder Wright in the Chemical Department of St. Mary's Hospital Medical School, and also taught occasionally in the Royal College of Science. On his return to Australia he found employment in the Government Analyst's Department in Sydney. In 1885 he was appointed Angus professor of chemistry in the University of Adelaide, in which capacity he rendered fine service.

Rennie's natural temperament and his upbringing gave him a strict view of his obligations, and he shrank from no labour that would enable him to fulfil them. It must be added that if he expected much from himself, he also expected that his students would do their full share. But his kindliness and sympathy tempered his sense of what was to be demanded from those whom he taught, and he was liked even as much as he was respected. His thorough knowledge of his subject and his sound training in the laboratory, with his capacity for clear expression and his wide outlook, made him an excellent teacher. Outside his own department he was devoted to the general work of the University, and he took a large share in the direction of its rapidly growing activities. He played a leading part in the institution of technical education in Adelaide, and was a warm supporter of the Australasian Association for the Advancement of Science. He also found time to do some research work, principally on the chemistry of Australian products.

Rennie was thoroughly happy when he was able to get away from his work to his boat and his fishing. His enjoyment on all such occasions was only matched by his disreputable appearance: many stories were told of his adventures by those who were invited to accompany him on his cheerful expeditions.

It was fortunate for the young University of Adelaide that its staff should include from early times and for so long a professor of such ability, integrity, good judgment, and tact. He set a fine standard at the moment when naturally it was most valuable; he was trusted by every one inside the University and out; and he helped materially to establish the University of Adelaide in a strong position and to build up its present good reputation.

Major J. R. Erskine Murray.

Major Murray was born in Edinburgh in 1868. At the University of Glasgow he studied under Lord Kelvin, and during the final years of his six years' course he did useful research work. He then entered Trinity College, Cambridge, as a research student. After being an assistant professor for two years at the Heriot-Watt College, Edinburgh, he was appointed an experimental assistant to Marconi. His interests now became centred in radio work. He acted as a demonstrator at University College, Nottingham, and as lecturer to the George Coats Technical College at Paisley. In 1907 he started consulting work in radio-telegraphy and gave lectures on it to Faraday House, London, and other colleges. In 1913 he became a partner in the firm of Messrs. Clarke, Forde, Taylor, and Erskine Murray, consulting engineers.

During the War Dr. Erskine Murray served with the Royal Air Force, being in charge of the radio instruments. He then became Experimental Engineer at H.M. Signal School, Royal Naval Barracks, Portsmouth.

Dr. Erskine Murray contributed several papers to various societies. Shortly after the War he gave to the Institution of Electrical Engineers a practical demonstration of communication by radio-telephony with an aeroplane in flight over London. His best-known book is a handbook on "Wireless Telegraphy," first published in 1907, which has gone through several editions, each edition having to be subjected to a thorough revision owing to the rapid progress of the art. He translated Ruhmer's "Wireless Telephony," to which he contributed a useful appendix. He also wrote a small but useful treatise on "Wireless Telephones and how they Work."

As an experimenter Erskine Murray's ability was of a high order. He took great pains in preparing experiments for his lectures, although he often used the very simplest apparatus. He had the gift of being able to communicate some of his enthusiasm to his students. His death after a very short illness has come as a great blow to his many friends.

We regret to announce the following deaths:

Mr. H. B. Goodwin, formerly examiner in nautical astronomy at the Royal Naval College, Greenwich, and the author of various works on this subject, on Feb. 24, aged seventy-nine years.

Mr. F. B. Guthrie, chemist in the Department of Agriculture, New South Wales, for some thirty years, and author of papers in Thorpe's "Dictionary of Applied Chemistry" and technical periodicals, on Feb. 7, aged sixty-five years.

Dr. Leopold Spiegel, extra-ordinary professor of the University of Berlin, who died suddenly on Jan. 8 at Charlottenburg in his sixty-second year. Prof. Spiegel, whose numerous investigations were chiefly upon alkaloids, was the discoverer of the drug yohimbin. He was also the author of several books on pharmacology, drugs, poisons, etc. For many years he was a member of the editorial board of the *Chemische Centralblatt.*

News and Views.

To-day is the centenary of the deaths of Volta and Laplace, who both died on Mar. 5, 1827, Volta being eighty-two years old and Laplace seventy-seven. Though in intellectual power Laplace was probably far superior to Volta, it may be that the electrical discoveries and inventions of Volta have had a greater effect upon the progress of civilisation than the profounder studies of Laplace. Each, however, in his own sphere did work which will cause his name to be recalled so long as science is studied. Volta's great contribution to science, the Voltaic pile, was made known in 1799, and that year also marked the publication of Laplace's immortal work "Mécanique Céleste."

Volta was born at Como in 1745 and came of a noble and ancient family. By 1774 he was holding a post in the Liceo at Como, and there, in the following year, he invented the electrophorus. Four years later he was appointed to the chair of physics in the University of Pavia. There were many students of electricity and magnetism during the eighteenth century, such as Gray, Canton, Dufay, Franklin, Nollet, Coulomb, Priestley, and Cavendish, and to these must be added Galvani, professor of anatomy at Bologna. Galvani for some years studied muscular contraction, especially in frogs, due to electric influence, but whereas Galvani attributed most of the effects obtained to animal electricity, Volta declared they could be traced to the contact of two metals in the presence of moisture. The landmarks in the history of the subject were Galvani's papers to the Bolognese Transactions in 1791, Volta's letters to Cavallo read to the Royal Society in 1793, and Volta's letter to Sir Joseph Banks read to the Royal Society in 1800. He had been awarded the Society's Copley medal in 1794, but it was in his letter of 1800 that Volta described the Voltaic pile and the "Couronne des Tasses." The new apparatus was early seized on by experimentalists, and the first Voltaic pile made in England was that of Nicholson and Carlisle, with which they decomposed water. In the hands of Davy the electric battery led to astonishing results, but these were all surpassed when Oersted for the first time discovered the influence of an electric current passing along a conductor on a magnetic needle, and thus founded the science of electromagnetism on which nearly all later developments have been based.

Laplace, less fortunate than Volta, came of poor parents and owed his education to wealthier neighbours. He was born at Beaumont-en Auge, Calvados, in 1749. Having taught mathematics for a while in his native place he went to Paris, enlisted the sympathies of D'Alembert, and found an instructor's place in the military school. Thence onward his progress was such that he was soon recognised as the rival of Lagrange. His memoirs of 1784 to 1789 on the motions of the moon, Jupiter, and Saturn are amongst the most important ever written. The Revolution found him an examiner to the artillery and a prominent member of the Paris Academy of Sciences and as such he did valuable work on the Commission of Weights and Measures. Though the academies were all suppressed in 1793, the fall of Robespierre was followed by the opening of the École Normale, the École Polytechnique, the National Institute, and the Bureau des Longitudes, in all of which Laplace took his place. His "Système du Monde" saw the light in 1796; the first part of the "Mécanique Céleste" in 1799. His famous nebular hypothesis was contained in the former. As an official he held office in 1799 as Minister of the Interior but only for six weeks, but afterwards he became a member, vice-president, and chancellor of the Senate. Under the Empire he was made a count and after the restoration a marquis. His later years were spent amid pleasant surroundings at Arcueil, where many paid homage to him. The last tributes to his memory were paid by Poissoin and Biot over his grave in Père la Chaise Cemetery, Paris, where he lay for sixty-one years. His remains were then exhumed and removed to Saint Julien de Mailloc, near his native place.

The modern treatment of leprosy is based mainly upon improved technique in the administration of chaulmoogra and hydnocarpus oils, or rather of the sodium salts or ethyl esters of their characteristic acids. In place of administration by the mouth, the drugs are now administered by intramuscular and intravenous injection, or by subcutaneous infiltration. Moreover, treatment is now continued over long periods of time. The bacillus of leprosy is a delicate organism, which can only secure a footing in an enfeebled host deprived of his natural powers of resistance by bad environment, scanty nutrition, or coincident disease. Residence under medical supervision in a well-organised leper colony suffices only to cure a small number of cases; the modern oil treatment has greatly increased the number of cures.

There are, however, still a considerable number of resistant cases, notably those of patients suffering from malaria, hookworm, or syphilis, who have been made vulnerable to leprosy infection. The difficulty is that the leper is apt to react to well-known drugs quite differently from the non-leprotic patient. Thus, Dr. E. Muir, of the School of Tropical Medicine and Hygiene, Calcutta, states that it is often dangerous to administer the usual arsenical drugs, such as neosalvarsan, to a syphilitic leper; so that it has become necessary to find a drug which combines the oil treatment referred to above with the antisyphilitic treatment for such cases. Such a drug has been prepared in the Wellcome Chemical Research Laboratories in London, under the direction of Dr. T. A. Henry, and has been tested since 1924 by Dr. Muir in India. The drug is a mercury derivative of metahydroxybenzaldehyde, rendered soluble in hydnocarpus or chaulmoogra oil, or in the ethyl esters made from these oils. It can therefore be injected in solution in these products, and the patient undergoes treatment for the two diseases at the same time. In the October issue of the *Indian Journal of Medical Research*, Dr. Muir gives the results of the treatment of thirty cases, all of which showed positive Wassermann reactions at the start. After treatment, sixteen became negative, two were doubtful, and only eight remained strongly positive, whilst all showed improvement so far as the concurrent leprosy was concerned. Not the least satisfactory feature of the new drug is its safety; in none of these cases did it give rise to undesirable symptoms.

ON Friday, Feb. 25, Sir Ernest Rutherford delivered the twelfth Guthrie Lecture to the Physical Society of London, assembled at the Imperial College of Science. Sir Ernest devoted the first part of his lecture to a description of the earlier work on the scattering of α-particles, which established the existence and charge of the nucleus; these experiments demonstrated that there is a wide region in the neighbourhood of the nucleus within which the inverse square law of force is obeyed, a remarkable point on which the lecturer laid stress. He then turned to the recent work on scattering carried out in the Cavendish Laboratory, in which, by the use of swift α-particles bombarding light nuclei, the law of force in the boundary regions of the nucleus itself has been investigated. Discussing the alternations of force which these experiments have established, he referred, not very hopefully, to the services which the new quantum mechanics might possibly render in elucidating the many puzzling features attending close collisions of nuclei. He concluded a fascinating lecture by describing a model of a radioactive nucleus, in which there is a nucleus within the nucleus, the inner nucleus possessing the full net positive charge, and being surrounded by circulating neutrons, *i.e.* α-particles neutralised by two electrons each. When such a neutron loses two electrons it is repelled and ejected as an α-particle. Sir Ernest appears to think that magnetic forces as well as electric forces will have to be invoked in future treatment of nuclear collisions.

IN his seventh Gifford Lecture in the University of Edinburgh, delivered on Friday, Feb. 25, on inorganic evolution, Prof. A. S. Eddington referred to the evolution of matter and of worlds as the beginning of a process which seems to reach its culminating point in the evolution of man. He reviewed the astronomical evidence bearing on the position of man in the universe—or in old-fashioned phrase, the 'plurality of worlds.' Is there reason to think that there exist other globes inhabited by beings which (however different physiologically) could be regarded as our compeers? In the solar system the two planets Mars and Venus are evidently the most eligible. Venus is swathed in thick clouds, and ideas as to what may lie beneath are entirely speculative. Mars presents a clear surface and invites more detailed study. On the important question of an atmosphere, it is now established that Mars has an atmosphere which, though thinner than our own, is probably adequate. Water is undoubtedly present, though in small amount. There are no oceans; but extensive clouds are occasionally photographed, and the white polar caps, which melt away entirely in summer, are snow deposits. Direct measurements of the surface temperature of Mars, by means of the heat-radiation from it, show that the climate is cold, but the temperature is not so low as to make life improbable. The remarkable feature is the regular seasonal change of the surface-markings. In the spring the dark markings spread greatly and encroach on the red (desert?) regions. It is not impossible that there may be some inorganic explanation, but the most natural hypothesis is that the change is due to the springing up of vegetation. If there is vegetable life, can we exclude animal life? But here the astronomer has come to the end of his facts and can take no responsibility for any further speculation. Prof. Eddington added that he does not think any weight can be attached to inferences sometimes drawn from the supposed artificiality of the so-called 'canals'; and further, it is exceedingly improbable that the zenith of evolution would happen simultaneously in two such widely different planets as Mars and the earth.

ON Mar. 1, the day preceding the delivery of the Frazer Lecture by Dr. Marett at Cambridge, Sir James and Lady Frazer entertained a number of friends at dinner in Trinity College. The presence in Cambridge of a large number of anthropologists for the purpose of attending the lecture, conferred upon the dinner a representative and official character, of which full advantage was taken to express the honour and esteem in which the author of "The Golden Bough" is held by his fellow-workers and disciples as well as by those eminent in other branches of learning. The eloquent and graceful tribute of Dr. Nairne, who proposed the health of Sir James Frazer, was followed by speeches from Lord Crawford and Balcarres, Chancellor of the University of Manchester, and Prof. E. Gardiner, formerly Vice-Chancellor of the University of London, on behalf of the universities, and by Mr. H. J. E. Peake, president of the Royal Anthropological Institute. The Rev. Edwin Smith spoke on behalf of workers in Africa, and Sir Frederick Whyte, first president of the Indian Legislative Council, represented India. The Master of Downing proposed the health of Dr. R. R. Marett as Frazer lecturer, and the latter in his reply referred to the sympathy and support given by Lady Frazer to Sir James in his work. Sir William Boyd Dawkins and Mr. E. N. Fallaize, honorary secretary of the Royal Anthropological Institute, who acted as chairman, also spoke.

A NEW quarterly periodical dealing with archæological matters is to appear shortly under the title of *Antiquity*. It will be edited by Mr. O. G. S. Crawford, Archæological Officer of the Ordnance Survey, Southampton, whose official position will serve as a guarantee that it will be closely in touch with recent discovery in England. The articles will be written by specialists, but will be popular in character and appeal to all who are interested in the development of human origins, dealing with archæological topics and giving news of current events more fully than is possible in the daily press, but in a more general form than in the technical journals. The periodical will have a wide scope and interest. Discoveries in Egypt, Mesopotamia, Crete, the Mediterranean, India, and Palestine will be given prominence; but British archæology will receive chief attention. A special feature will be the extensive use of air photographs for the purpose of illustration. In the list of contributions already promised a wide field is covered by writers of authority, including the more prominent continental archæologists. The subscription price is £1 per annum.

We have received copies of the November and December issues of *Rivista di Fisica, Matematica and Scienze Naturali* (Naples), these being the first numbers of the second series of this review, which was founded at Pavia in 1900 by Prof. Pietro Maffi, but came to an end in the early days of the War. A photograph reproduced in the December number of the journal shows that at the summit of Vesuvius there still exist portions of the vast abyss which was formed during the eruption of 1906 and was then about 300 metres deep but is now only 100 metres. Since the decapitation of the great cone was oblique with an inclination towards the north-east, in that quadrant the depth is barely 20 metres, so that a further flow of lava from this side may be expected. At the south-west quadrant of the crater platform there stands the small eruptive cone, which is about 60 metres high, but varies in height from day to day owing to the constant demolition and reconstruction caused by the almost continuous explosions of scoria. The filling of the abyss has been, and is still being, effected by the ashy materials emitted from the eruptive cone and by the lava extruded from time to time from radial crevices opening in the flanks of the same cone.

Sir Sydney Chapman, permanent secretary of the Board of Trade; Sir Alexander Gibb, consulting engineer; and Sir Israel Gollancz, secretary of the British Academy, have been elected members of the Athenæum Club under Rule II., which provides for election by the Committee of "persons of distinguished eminence in science, literature, or the arts, or for public services."

A flying expedition to the Antarctic is being planned by Senor Antonio Pauly, who recently laid his plans before the Sociedad Argentina de Estudios Geographicos. The *Geographical Journal* for February gives some details. The main idea involves the route originally proposed by Dr. W. S. Bruce and later adopted by Sir E. H. Shackleton, of a traverse of the continent from the Weddell Sea to the Ross Sea. But the starting-point will be Wandel Island on the west coast of Graham Land, which has been chosen on account of its level surface and accessibility by sea. Here a scientific station will be established, subordinate to the main expedition. A reconnaissance by air will establish an advanced base on the coast or in the interior of Graham Land about latitude 70° S., where a petrol depot will be formed. The final flight will be made from this base, landings being made *en route* for the purpose of scientific observations. By arrangement with the whalers in the Ross Sea, it is hoped to lay down depots of provisions in McMurdo Sound. The project holds out the prospect of useful scientific results, but the flight would be a long one through unknown atmospheric conditions, and its chance of success is not enhanced by the proposal to make several landings on the way. It is not proposed to start for at least another year.

The Ecclesiastical Commissioners have agreed to lease to the East Riding Antiquarian Society the old tithe barn at Easington, erected about A.D. 1500, and one of the few of its type still in existence, for the purpose of an 'out door' museum. In it will be exhibited the collections of obsolete farming appliances of various types and the large series of objects illustrating country life now in the possession of the Hull municipal authorities. Other exhibits will accrue, no doubt, as time goes on. The provision of alternative accommodation for the present tenant and other requirements will necessitate an expenditure of £645, towards which subscriptions are asked. This appeal is one which should be supported by all who realise the importance of preserving the fast disappearing relics of the local and peasant industries of England. Donations should be sent to Mr. T. Sheppard, The Museum, Hull.

The Electricity Bill having given its sanction to a great network for interlinking generating and distributing stations for electrical power in Great Britain, engineers are beginning to look ahead and study the problems which will have to be solved if continuity of supply is to be safeguarded. In a paper to the Institution of Electrical Engineers on Feb. 17, Mr. F. H. Clough read a paper on "The Stability of Large Power Systems," which is a question of ever-growing importance. He concludes that synchronous motors, that is, motors which run exactly in step with the generators, can be made sufficiently stable for all usual power supply purposes. It is necessary, however, to consider not only the maximum power for which the circuit has been designed, but also that which the system may have to carry momentarily if a fault develops. In America it has been found that even with 220 kilovolts between the transmission lines, quite satisfactory results have been obtained up to distances of 250 miles. When the length was increased to 400 miles the conditions for stability became apparently quite different. The problem in this case presents considerable mathematical difficulty.

FOR purposes of trans-Atlantic Telephony, the 'fifth' American zone, which comprises all places in the States of Washington, Oregon, California, Nevada, and Arizona, has now been made available. The charge for a call from any place in the fifth American zone to any place in Great Britain is £17 : 8*s.* for the first three minutes and £5 : 16*s.* for each additional minute or fraction thereof. A 'report charge' of £2 is made when a 'particular person' call cannot be effected. The whole of the United States is now in telephonic communication with the whole of Great Britain. The pioneers of this system deserve great credit for overcoming the many almost insuperable obstacles with which they were confronted, and for their patient perseverance. Research is being pushed forward with renewed vigour and we are looking forward to new developments.

MR. C. D. SHERBORN has presented to the Trustees of the British Museum (Natural History) the late Sir Richard Owen's first draft plan embodying his proposals, drawn up in 1859, for the Natural History Museum. The Department of Zoology has received from Mr. R. St. G. Burke 100 heads and skulls of Indian carnivora and ungulates, including an exceptionally fine series of Chital or spotted deer and five Sambar from the United Provinces. Dr. L. W. Sambon has presented to the same Department his collection of Linguatulida, a little-known group of parasitic animals generally regarded as being allied to the mites. Dr. Sambon's collection, which comprises 134 specimens, almost doubles the existing Museum collection of the group. The Department of Entomology has acquired some 22,000 specimens of insects, mainly Diptera, as a result of an expedition made by Mr. F. W. Edwards, a member of the staff of the Department, to north-west Patagonia. Recent donations to the Geological Department include thigh-bones of two plesiosaurs, one from the Kimeridge Clay of Dorset, the other from the Weald Clay of Sussex, from Dr. Pope Bartlett and Mr. S. Tooth respectively; and cephalopods and other molluscs from cretaceous rocks of Portuguese East Africa, presented by Dr. S. H. Haughton and Captain M. P. Traill-Smith, and from similar rocks in Great Britain by Lieut.-Colonel R. H. Cunnington. Dr. Hamshaw Thomas has given type-specimens of fossil plants (Bennettitales) from the Inferior Oolite of the Yorkshire coast. It is very satisfactory to note the increasing readiness of investigators to present to the Museum the specimens that have served as the basis of scientific work. During 1926 no less than 165 type specimens and 297 figured specimens were given by twenty workers at universities and similar institutions to the Geological Department. Indispensable as such specimens are to every serious student, their preservation is a fitting object of national concern.

IN the January number of the *National Geographic Magazine* (vol. 51, No. 1, Jan. 1927, Nat. Geog. Soc., Washington, D.C.), an account is given of the experimental work of Dr. W. H. Longley and Mr. Charles Martin on natural-colour photography under the sea, and eight illustrations—the first published—show the perfection to which they have attained. The work was carried out off the Dry Tortugas Island, the most western of the Florida Keys. A special technique was developed to hypersensitise the plates and so reduce the under-sea exposure to a twentieth of a second. This proved satisfactory in shallow water, but when it came to a depth of 15 feet a method had to be devised to supplement and intensify the light. A flash-light mechanism was therefore constructed which would float on the surface but yet be under the direct control of the submerged photographer to be guided by him and discharged as required. Two men in a dory followed the diver to maintain the necessary supply of air, but at a sufficient distance from the float to avoid any danger arising from the powerful explosions. The float was made of three pontoons supporting a dry-cell battery, the flash-light, each charge of which consisted of a pound of magnesium powder, and the white reflector. The camera used was enclosed in a brass case with a plain glass window in front of the lens. A supplementary hood was fitted above the regulation reflector, and by means of an acute-angled mirror the photographer was able to focus his instrument looking directly in front of him, a necessary measure owing to the difficulty of bending over the camera while wearing diving-dress. The photographs give a vivid impression of the wealth and variety of form and colour under the sea, those showing the colour-changes of the different fishes reacting to their surroundings being particularly fine.

AT the annual general meeting of the Optical Society, held at the Imperial College of Science, South Kensington, on Feb. 10, the following officers and members of council were appointed for the session 1927–28: *President*, Dr. R. S. Clay; *Vice-Presidents*, Mr. F. F. S. Bryson, Mr. H. H. Emsley, Mr. J. Guild, Mr. F. C. Watts; *Hon. Treasurer*, Major E. O. Henrici; *Hon. Secretaries*, Prof. A. F. C. Pollard, Imperial College of Science, South Kensington, S.W.7; Mr. W. B. Coutts, Artillery College, Woolwich, S.E.18; *Hon. Librarian*, Mr. J. H. Sutcliffe; *Editor*, Dr. J. S. Anderson; *Council*, Mr. D. Baxendall, Mr. W. M. Brett, Mr. E. F. Fincham, Mr. E. T. Hanson, Instructor-Commander N. M. S. Langlands, R.N., Prof. A. O. Rankine, Mr. H. C. Raxworthy, Mr. J. Rheinberg, Dr. G. F. C. Searle Mr. W. Swaine, Mr. R. S. Whipple, Colonel H. S. L. Winterbotham.

THE ninety-fifth annual meeting of the British Medical Association will be held in Edinburgh on July 15-23. According to the provisional programme, the incoming president, Sir Robert Philip, will deliver his address on Tuesday, July 19, at 8 P.M. Throughout the meeting the annual exhibition of surgical appliances, foods, drugs, and books will be open for inspection. The honorary local general secretary of the annual meeting is Dr. A. Fergus Hewat, 14 Chester Street, Edinburgh. A Lister Centenary Celebration is also being arranged at Edinburgh in July in connexion with the meeting. Throughout the week, a museum of Lister relics will be on view in the Upper Library of the Old University.

On July 20 a public meeting will be held, presided over by Lord Balfour, and Sir Watson Cheyne, Prof. T. Tuffler (Paris), Prof. Harvey Cushing (Harvard University), and Prof. James Stewart (Dalhousie University, Halifax, Nova Scotia) will deliver addresses. Inscriptions are to be placed on the walls of 11 Rutland Street and 9 Charlotte Square, both of which were occupied by Lister while in Edinburgh, and a prize of £25 and a gold medal is offered for an essay on "The Influence of Lister on Surgery," the competition being limited to first-year students of medical schools of the British Empire. A Lister memorial volume, edited by Dr. Logan Turner, is in preparation; in addition to personal reminiscences of Lister, it will contain chapters on surgery before and after Lister by Mr. Alexander Miles and Prof. Fraser respectively, while Sir E. Sharpey-Schafer will deal with Lister's work as a physiologist.

A useful catalogue (No. 148) of books on gardening and botany has just been circulated by Messrs. Dulau and Co., Ltd., 34 Margaret Street, W.1. It gives the titles of nearly 900 works classified under appropriate headings and should be of service to many readers of Nature. It will be sent free of charge to any applicant.

Applications are invited for the following appointments, on or before the dates mentioned:—An assistant chemist at the Fruit and Vegetable Preservation Research Station of the University of Bristol, Campden, Gloucestershire—The Resident Director, University of Bristol Research Station, Campden, Gloucestershire (Mar. 14). A keeper of the Birmingham City Museum and Art Gallery—The Town Clerk, Birmingham (Mar. 19). A director of research under the British Cotton Industry Research Association—The Secretary, British Cotton Industry Research Association, Shirley Institute, Didsbury, Manchester (Mar. 21). A headmaster of the R.N. College, Dartmouth—The Secretary, C.E. Branch, Admiralty, S.W.1 (Mar. 21). Chemical assistants in the public health department of the L.C.C.—The Clerk of the L.C.C., County Hall, Westminster Bridge, S.E.1 (Mar. 25). A director of research into the prevention of water pollution and cognate problems—The Secretary, The Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1 (Mar. 31). A lecturer in advanced and economic entomology in the University of Cambridge—The Registrary, University, Cambridge (May 31). A chemist and metallurgist in the Egyptian Government Assay Office, Cairo—The Chief Inspecting Engineer, Egyptian Government, 41 Tothill Street, S.W.1. An entomologist under the Sierra Leone Government, principally for tsetse fly investigation work—The Private Secretary (Appointments), Colonial Office, 38 Old Queen Street, S.W.1. A junior assistant in the physics department of the Experimental Station, Porton, Wilts—The Commandant, Experimental Station, Porton, Wilts.

Our Astronomical Column.

Brilliant Fireball on Feb. 25.—Mr. W. F. Denning writes: "This object appeared at 11.54 p.m. and caused a vivid illumination of the sky over the south-west of England. There was a double outburst resulting in two flashes of dazzling intensity. Some observers thought the size of the nucleus about equal to that of the full moon, but considered the luminous effect greater than that of the moon coming suddenly from behind dark clouds. The light was white, similar to that of magnesium. The flight was slow, and perhaps occupied 3 seconds in traversing 20°. A considerable number of descriptions are coming in from various places, but for scientific purposes very few are of use. Before the path of the body can be ascertained, more data must be awaited. There is a strong probability, however, that the meteor was directed from a radiant point in Leo and that it passed over the south-east region of Devonshire, falling from 66 miles to 26 miles in height at a velocity of 18 miles per second. Several large fireballs have been directed from this radiant (near Regulus) at the end of February in past years."

Solar Radiation.—In *Memoirs of the Imperial Marine Observatory*, Kóbe, vol. 3, No. 1, R. Sekiguti gives the results of an investigation undertaken by him for the purpose of detecting a possible direct effect of the sun's activity on air temperatures. The Greenwich daily sunspot areas are correlated with daily temperature rises observed for a standard type of weather. The meteorological data were collected from five stations in the plateau district of central Japan, and a selection was made from the years 1905–13 according to certain criteria of cloudiness, wind velocity, etc. The general conclusion advanced by the author is that there is an indication that small temperature rises occur with an inactive solar surface, and that moderate sunspot activity is responded to by high temperature rises. This conclusion is stated with diffidence, and the scantiness of the meteorological data and the difficulties of dealing with air temperatures for this purpose are frankly admitted.

The Sun's Motion derived from Faint Stars.—Perplexity has frequently been caused by the wide discordances between the positions of the solar apex when derived from stars of different magnitudes. These have in some cases been traced to systematic errors in the adopted proper motions. Mr. P. van de Kamp (*Bull. Astron. Instit. Netherlands*, vol. 3, No. 112) gives a new determination, based (1) on the photographically determined proper motions of 1900 tenth magnitude stars, uniformly distributed, but all north of declination −30°; (2) from the radial velocities of 105 stars of magnitudes 9-10 within 50° of the solar apex or antapex. The combined result for visual magnitude $10^{m}{\cdot}1$ gives for the apex, R.A. 277°±3°; Decl. 38°±3°, if Raymond's corrections are applied to Boss's proper motions in decl., or 31°±3° if van Rhyn's further corrections are applied; solar velocity 18±2·2 km./sec. for visual magnitude 9·2. These results are in fair accord with W. W. Campbell's values derived from the radial velocities of 2034 stars brighter than 5·5, namely, R.A. 268°·9±2·2, Decl. +27°·2±1°·7, Vel. 19·0±0·6 km./sec.

Research Items.

Prehistoric Cultures of Siberia. — While certain parts of Central Asia and Mongolia have recently attracted the attention of anthropologists and archæologists, the neighbouring country of Siberia remains scarcely explored in this respect. This consideration induced the State Russian Museum (formerly the Museum of Alexander III.) in Leningrad to send a palæ-ethnological expedition to the Altai mountains during 1924-1925. The expedition, under the leadership of Prof. S. J. Rudenko, explored in a systematic way a very large part of the country, and the results of the numerous excavations made indicate that the cultural life of the country was very intensive. The earliest remnants found belong to the later phase of the stone age; the skeletons found were brightly painted with ochre. About twenty places, with remnants of the bronze age, have been explored, and numerous articles, ornaments, and implements found. Some rather more recent stone graves discovered on the River Tchulishman contained, amongst other things, ornaments plainly indicating some connexion between the Altai nomads of those days and the Byzantinian culture.

The Indians of Huaxtec.—The recently published vol. 18 of the *Journal de la Société des Américanistes de Paris*, contains a study by Dr. Waltier Staub of the area known to the Aztecs as *Cuextlan* (Shores of the Salt Water), and to-day known as Huaxtec—land on the eastern side of the Mexican plateau, bordering on the steppe country of the north in which the culture of the nomad tribes contrasts with that of the settled agriculturists of the low-lying lands below. The special interest of this area from the ethnological point of view is that the inhabitants would appear to be an early offshoot of the Maya. At the time of their first settlement they would appear, judging from certain clay figures found in the alluvium of the Rio Panuco, to have been already acquainted with weaving and pottery-making. On the other hand, the absence of stone temples, of hieroglyphs, or any system of writing, indicates a fission before the Maya were acquainted with the calendar or had developed their system of writing. According to Lehmann and Sapper, the dialect which most closely resembles the Huaxtec of to-day is the Chicomucelotec of the frontier of Chiapas-Guatemala, their separation being due to an incursion of Totonacs and Olmecs towards the Atlantic coast. The geographical position of the Huaxtec country, borderings on the steppe lands, made it more suitable for hunting and fishing than agriculture, and it was thus left free from the intrusion of other peoples; while it was never occupied by the Aztecs, although it paid tribute to them. The inhabitants were thus able to preserve their culture and their language unaffected. The Huaxtecs of to-day are still extremely primitive, living in hamlets in bamboo circular huts, often without chairs or tables. They sleep on the ground and do not use the hammock. The principal deity of the pre-Columbian Huaxtecs was the earth goddess, and until recent years sculptured representations of her were frequently to be found on the hills, but of these many have now been removed for sale.

Nematode Eggs from Skin and Gills of Shark.—G. A. MacCallum records (*Proc. U.S. Nat. Mus.*, Vol. 67, Art. 16, 1925) the occurrence of the eggs of a nematode, probably a species of Capillaria, on the under surface of the nose, in front of the mouth, of a large shark, *Carcharinus commersoni*, taken near Woods Hole. The dark brown, almost black, eggs were laid in the groves between the scales and attached by transparent adhesive material. Similar eggs were found on the lighter coloured portions of the fins of another shark of the same species. In a later paper (vol. 70, Art. 6, 1926) the same author records eggs, tentatively referred to the genus Capillaria, on the gill arches of *Carcharinus milberti* at Woods Hole. These eggs are in patches, sometimes two inches long by half an inch wide, and the egg shell is spinous. In neither case were adult worms found which could have laid the eggs.

Creeping Eruption in America.—A short note in the *Official Record of the U.S. Dept. of Agriculture*, vol. 5, No. 43, Oct. 1926, summarises the recent work on creeping eruption in man by J. L. Kirby-Smith, W. E. Dove, and G. F. White (see *Arch. Dermatology*, 13, 1926, pp. 137-173). The eruption is caused by a nematode larva. During a further study, Messrs. Dove and White have recovered infective nematode larvæ from the fæces of the dog and the cat in a locality where there was a high incidence of creeping eruption. The larvæ were applied to the human skin and produced the characteristic symptoms and lesions. These larvæ have "in general the appearance of hookworm larvæ." In 26 out of 27 dogs from the streets of Jacksonville and in both of two cats, Ancylostoma were found and two species identified as *A. braziliense* and *A. caninum*. The authors state that further work is in progress. Creeping eruption occurs chiefly in the South Atlantic and Gulf States, but it has been reported so far north as New Jersey and inland so far north as Oklahoma. Damp sand in these areas has been observed to be a favourable environment for the parasite and a likely location for infection.

Medusæ of the Danish Ingolf-Expedition.—Dr. P. L. Kramp, of the Copenhagen Zoological Museum, gives a most interesting account of the Anthomedusæ of the Danish Ingolf-Expedition (vol. v. 10, Medusæ, Part 2, Copenhagen, 1926). This work follows the same plan that was used in the Leptomedusæ (Kramp, 1919) of the same expedition, the main study being the horizontal and vertical distribution, seasonal occurrence and dependence on the various hydrographical conditions. Whilst keeping these points in view, however, the author is able to show a great deal that is new with regard to the comparative morphology of many of the species, especially of those belonging to the Codonidæ. Such points as the structure of the manubrium, morphology of the tentacles and their basal bulbs, and the abaxial spurs are dealt with in detail and show important features useful in classification. *Sarsia tubulosa*, that common and much-discussed species, or group of species, is fully investigated, the conclusion being that most of the closely related forms such as *S. decipiens*, *S. pulchella*, and *S. mirabilis* are merely local varieties. An interesting point is shown in the fact that the farther north it is found the more the time of occurrence of this medusa is delayed, the liberation from the hydroid taking place later in the colder regions. That the farther north we go the later the medusa is budded off seems to be a general principle for these northern forms. The author places *S. flammia* in the genus Euphysa, having found therein certain muscular bands which probably do not exist in Sarsia. *Corymorpha nana* is the hydroid of *Euphysa aurata*, the latter probably being a separate species from *E. mediterranea*. Interesting facts are noted amongst those proliferating medusæ *Lizzia blondina*, *Rathkea* *octopunctata*, and *Hybocodon prolifer*. In the first species, apparently all the young specimens normally bud and later on each one becomes sexually mature, whereas in the other two the first budding generations probably never become sexually mature. The budding of Rathkea in one and the same area is dependent on the water temperature, being accelerated and ceasing earlier when the water is warm than when it is cold.

The Biology of the Saw-toothed Grain Beetle.—In the *Journal of Agricultural Research*, vol. 33, No. 5, 1926, Messrs. E. A. Back and R. T. Cotton record a number of interesting observations on the biology of this cosmopolitan insect. Although it may occur in almost any stored food of vegetable origin, and has been known for more than 150 years, the life-cycle of *Oryzæcephalus surinamensis* Linn. has received but little attention from entomologists; even Redi in 1671 figured an insect which is very possibly this same species. Linné received specimens from Surinam, and for that reason gave it the specific name by which it is known. A remarkable fact brought to light by Messrs. Back and Cotton is the longevity exhibited by the adult beetle. Under laboratory conditions, male individuals lived more than two years, and one example survived for three years and three months. The females appear to be shorter lived; few lived longer than one year, but one example survived for two years and eight months, laying 216 eggs during that period. Under the most favourable weather conditions, the whole life-cycle may be passed through in 27 days. On the other hand, low temperature may prolong the period to 315 days. At Washington, D.C., there are four or five generations annually, but in the tropics there are doubtlessly more. It is interesting to note that a temperature of 0° to 5° F. for one day will kill all stages, and if the temperature be raised to 125° F. all stages succumb within an hour. A vacuum of 29 in., continued for seven hours, killed the adult insects.

The Landfall of Columbus.—In a paper read before the Royal Geographical Society on Feb. 14, Lieut.-Commander R. T. Gould returns to the much-debated question of which island in the Bahama group Columbus first sighted. Since the original journal of Columbus is lost, the available evidence is circumstantial and indirect, and at best can indicate only the most probable island. At the outset Commander Gould dismisses, as unsupported by any evidence, the suggestion that volcanic disturbances or changes in sea-level may have altered the appearance and distribution of the islands since Columbus's voyages. The island which Columbus named San Salvador was clearly one of the Bahamas and has been variously identified with Cat, Grand Turk, Watling, Mariguana, and Samana Islands. Commander Gould discusses in turn the grounds for each identification in the light of the evidence available. This falls under several heads; (1) Courses and distances sailed by Columbus between his departure from Gomera in the Canaries and Guanahani, the native name of his landfall, for which the material is very scanty; (2) evidence from the small-scale chart of Cosa (1500) or the chart of Herrara (1601); (3) comparison of Columbus's description of Guanahani with the various likely islands as they exist to-day; (4) plotting on a modern chart the relative bearings and distances of the islands discovered by Columbus. The result of each line of researches leads Commander Gould to the same conclusion, that Columbus's landfall was Watling Island, now also known as San Salvador.

Mineral Deposits in Russia.—Results of current research in mineralogy in Russia are being published mainly by the Institute of Applied Mineralogy and Metallurgy in Moscow, and by the Geological Committee of Leningrad. The Moscow Institute published during 1926 some ten papers of considerable practical and theoretical interest, including the results of original investigations on the chemistry of minerals by Ginsberg, and on kaolin and other deposits in the Urals. An outstanding work is that by V. A. Obrutchev on "Metallogenetic Periods and Regions of Siberia"; the author finds six separate metallogenetic periods in Siberia; Archean (numerous deposits of gold, and several of iron, silver, lead, and molybdenum); Eozoan (still more gold, some copper, iron, and tungsten); Caledonian (little gold; deposits of copper, silver, lead, zinc, and tungsten also not numerous); Hercynian (gold deposits rare, but those of polymetallic ores numerous; some tin, tungsten, and mercury); Tian-Shanian (polymetallic ores prevalent; nickel, platinum, copper ores); Meso-Neozoan (gold, copper, silver, lead, zinc, iron, bismuth). A geo-morphological survey of Siberia is given by the author and important bibliography appended. In the series of publications by the Leningrad Geological Committee there is an interesting report by A. D. Natsky on the sulphur deposits in the Karakum desert of Turkestan; M. M. Tetaiev gives a classification of Russian tungsten ores, and A. K. Meissner presents an almost monographic description of gold deposits of Russia.

Devonian Flora.—The most important contribution to Devonian palæobotany since the discovery of the Rhynie fossils is described by Dr. Dukinfield Henry Scott in the *New Phytologist* (vol. 25, No. 5). The new specimens, which came from several localities near Elberfeld and belong to the lowest division of the upper Middle Devonian, have been investigated by Drs. Kräusel and Weyland (*Abhandlungen der Senckenbergischen Naturforschenden Gesellschaft*, Bd. 40, Heft 2, 1926). So far they have described the following five plants: *Asteroxylon elberfeldense* n.sp., *Aneurophyton germanicum* K. and W., *Hyenia elegans* n.sp., *Calamophyton primaevum* n.gen. et sp., *Cladoxylon scoparium* n.sp. There is a far-reaching agreement between the Elberfeld and the Rhynie Asteroxylon. They differ, however, in the presence of pith in the German form, in the stellate form of stele, and in the occurrence of pitted tracheids. Aneurophyton was probably a tree with the habit of a tree-fern, and its frond structure may throw some light on the question of the origin of the fern-like frond. The chief point of interest in regard to *Hyenia elegans* is the presence of the fructification, previously unknown in the genus, and taking the form of loose spikes with numerous forked sporangiophores arranged on the axis. On account of the dichotomous branching, *H. elegans* and *Calamophyton primaevum* are relegated to two distinct series of a new class, the Proto-articulatæ, although, in view of the close agreement in the structures of their fructifications, there seems some reason for including them in one series. The last species, *Cladoxylon scoparium*, is an unexpected find in the Middle Devonian, and the external habit and the fructification, hitherto unknown, have now for the first time been revealed. "The discovery of this Middle Devonian species must reopen the disputed question of the Upper Devonian or Lower Carboniferous age of the Saalfield Cladoxylons."

The Spectrum of Argon.—A few years ago, F. Paschen succeeded in analysing the complicated line spectrum of neon. A similar analysis has now been effected for the 'red' spectrum of the next inert gas, argon. In two recent papers (*Zeits. f. Phys.*, 39, p. 172, and 40, p. 839) K. W. Meissner has shown that this, too, can be derived from four sets of *s*-terms, ten of *p*-terms, and twelve of *d*-terms. Most of the wave-numbers are from his own measurements, but some lines observed by other workers in the ultra-violet fall into the same scheme. An interesting consequence has been pointed out by W. Grotrian (*idem*, 40, p. 10). The screening effect of the inner electrons for the X-ray $M_{II}M_{III}$ doublet in the heavy elements, in which the *M* shell of electrons is complete, is such as to reduce the effective nuclear charge by 8·5. Meissner's analysis shows that the screening constant is 7·3 for argon, where only the first eight electrons of the *M* shell are present; for the next element, chlorine, its value is 7·5.

Structure of the Molecule of Carbon Monoxide.—Recently spectroscopists have been able to show, from the analysis of some carbon band spectra, that the outer electrons in an excited carbon monoxide molecule have energies which fall into a scheme very similar to that for an atom of the second group of the periodic table. This analogy has now been extended by F. L. Mohler and P. D. Foote (*Phys. Rev.*, 29, p. 141, 1927). By the 'partial current' method for measuring excitation potentials, the effect of inelastic collisions of an electron with gas molecules is shown by the change in the electron current to a collecting electrode as the energy of the electrons is varied. When such experiments are made with carbon monoxide and mercury vapour under comparable conditions, the current–voltage curves obtained exhibit an astonishing similarity. The form of the curves yields information about the relative probability of occurrence of the possible quantum transitions, and it is concluded that not only the energy levels, but also the movement of a valence electron from one to another of them, are alike in the respective molecules and atoms.

The Pycnosonde.—A new instrument for measuring the specific gravity of sea water, invented by Dr. D. la Cour of the Danish Meteorological Institute, is described in the *Marine Observer* for March. It consists of a glass tube bent twice at right angles and fixed on a metal frame for protection. One branch of the tube is narrow and the other wide. The narrow end is open and the wide end is closed by a water-tight valve opening inwards. As the tube is lowered in the sea the increasing pressure slowly forces water in through both ends and the air is compressed in the upper part of the wide arm. When the instrument is hauled up the valve keeps closed as the pressure decreases, and the expanding air escapes by the narrow arm. When the surface is reached the wide arm contains a complete sample of the various waters through which the instrument has passed, arranged in the proper order. In the wide arm, before lowering, are arranged small coloured glass floats—pycnodevils—of certain specific gravities. They assume positions in the column of water corresponding to certain definite values. Thus when the pycnosonde is brought out of the water the pycnodevils have arranged themselves at different heights, and the depths to which these heights refer can be readily determined by a suitable scale. It has been found in practice that there is no appreciable mixing of the layers of water in the tube even when the temperature of the whole instrument is altered. It is claimed that in shallow water this instrument works well, and can be used from a moving vessel with the Kelvin sounding machine.

Micromagnetic Oscillations at Zouy.—In *Terrestrial Magnetism* for September 1926, Arnold Podder, of the Meteorological and Magnetic Observatory at Zouy (formerly Irkutsk), Russia, discusses the micromagnetic oscillations observed there by sensitive magnetographs. Two very different types of these waves are found to exist; in one the vibrations continue very regularly for hours or even days, with well-defined periods of from 5 to 15 seconds. In the other type the vibrations, though less regular, have a pronounced periodical character, the periods being considerably longer, however, with an average value of about 35 seconds. A year's observations are discussed, relating to all three magnetic elements; the vertical force observations were made both by a balanced magnet and by a horizontal coil. In the short-period oscillations the intensity increases with the period (from about 0·5 γ for 5 seconds period to about 2·5 γ for 15 seconds period—the intensity being nearly the same in the horizontal and vertical components); 90 per cent. of these vibrations have periods between 7 seconds and 9 seconds. They occur particularly between midday and 7 P.M. local time, while at night the longer periods are more prominent. No hypothesis is advanced as to the cause of the vibrations, but certain similarities to microseismic waves are pointed out.

Formation of Ammonia in the Silent Discharge.—Warburg and Rump (*Zeit. fur Phys.*, vol. 40, p. 557, 1926) have recently studied the formation of ammonia in the silent discharge and have compared the results with those obtained in the production of ozone by the same method. A mixture of nitrogen and hydrogen was passed so quickly through a Siemens' tube that the amount of ammonia formed was so small that any decomposition could be neglected. It was found that the ammonia was formed chiefly at the walls, whilst the ozone is formed chiefly in the interior of the discharge tube, probably because of the greater heat of dissociation of nitrogen and the catalytic action of the surface of the tube. Variation of pressure produced very much less effect in the case of the production of ammonia than in the case of ozone, presumably because the number of ionic collisions at the walls was very small compared to the number in the interior of the gas.

Characterisation of Genuine Proteins.—The Hugo Muller Lecture, which was delivered before the Chemical Society by Prof. S. P. L. Sorensen on Oct. 28, 1926, has been published in the Society's *Journal* for Dec. 1926, and it gives an account of some of the diverse problems which, at the present moment, occupy the attention of those engaged in a study of the composition of the proteins. These problems are of two kinds: the first deals with the nature of the simpler compounds from which the protein molecules are built up, while the second is concerned with their 'elementary' composition. The decomposition products which can be obtained by treating the proteins with acids, alkalies, or suitable enzymes, form the most important clue as to protein structures, and about twenty such substances are now known. It is considered that protein molecules consist of a number of loosely knit polypeptide complexes, and this view accounts for the remarkable properties that the proteins possess. With regard to their elementary composition, it is well known that all protein substances contain carbon, hydrogen, oxygen, and nitrogen, and most of them also small quantities of sulphur and phosphorus. Since the sulphur and phosphorus contents are small, it has been suggested that the sulphur- or phosphorus-containing compounds are only loosely associated with the protein molecules, and are not integral constituents of them. Careful fractionation has shown that this is true of the serum proteins, but the phosphorus in egg albumen appears to be intimately bound up with the rest of the molecular complex.

The Genetics of Wheat Species.

RECENT years have witnessed important advances in our knowledge of the wheats, which are now recognised to fall into three well-marked groups, differing in their chromosome numbers and rust resistance, and showing inter-sterility when members of different groups are crossed. Much genetical work has been devoted, not only to crosses between hexaploid and tetraploid or tetraploid and diploid species, but also to crosses between species having the same chromosome numbers. In the latter series of crosses, in which there is relatively full fertility, various investigators, including Tschermak, Nilsson-Ehle, Engeldow, Percival, Kajanus, and Malinowski, have taken part. The results of these crosses between wheat species having the same chromosome numbers have been much simpler than might have been anticipated, and they raise some interesting questions concerning the relationships between these species, the nature of the differences involved, and the manner in which these differences are germinally represented.

Some of these questions are discussed in a recent paper by Prof. E. Malinowski (*Jour. of Genetics*, vol. 17, No. 2), in which he propounds the view that the phenomena can be explained by assuming linkages between different pairs of chromosomes. Such linkages would resemble in some respects those which are known to occur between many of the chromosomes of Oenothera species. Such connexions between chromosomes have not yet been described as regular occurrences in the wheats, although much cytological work has been done on this group, and there are other difficulties with the hypothesis proposed, which, nevertheless, will doubtless lead to a further analysis of the differences between species of wheats.

In 1914, Malinowski found that a cross between the two hexaploid wheats, *Triticum Spelta* and *T. vulgare* (each with 42 chromosomes), gave an intermediate F_1 and an F_2 which contained *T. Spelta*, the intermediate type, and *T. vulgare* in the ratio 1 : 2 : 1, although an independent factor for *T. compactum* (club wheat) was also present. Kajanus confirmed the 1 : 2 : 1 result. Now *T. Spelta* has longer ears than *T. vulgare*, and its glumes and spikelets also have a different shape. Hence, in spite of the monohybrid behaviour, it appears probable that a number of (linked) genetic differences are involved. Whether it is necessary to assume that these factors reside in independent chromosomes which have become linked, as Malinowski suggests, remains to be seen.

In crosses between *T. polonicum* and *T. dicoccum*, both tetraploid species with 28 chromosomes, the same 1 : 2 : 1 ratio is obtained in F_2, although here again an independent factor for long or short glumes may be present. The same ratio obtains when *T. polonicum* is crossed with *T. durum*, another tetraploid species.

When a tetraploid is crossed with a hexaploid wheat, the results are much more complicated. For example, in *T. polonicum* × *T. vulgare* the F_1 pentaploid hybrid is intermediate, but the F_2 segregates into a great variety of types, including *T. dicoccum*, *T. durum*, and *T. polonicum* ($4n$ chromosomes), as well as *T. Spelta* and *T. Vulgare* ($6n$). Some of the F_3 families show segregation between two species in a 1 : 2 : 1 ratio. But they are always both tetraploid or both hexaploid species, *i.e.* they might be *durum* and *polonicum*, or *dicoccum* and *polonicum*, or *vulgare* and *Spelta*. The least complicated segregation between forms having different chromosome numbers is in crosses between *T. dicoccum* and *T. Spelta*. This yields in F_2 *dicoccum*, *Spelta*, and two other types which resemble these respectively.

In his explanatory hypothesis Malinowski assumes that the tetraploid wheats have two linked chromosomes, while the hexaploid forms have three, and that certain of these linked chromosomes are common to different species, *e.g.*, *T. dicoccum* having *a* and *c* linked, while *T. Spelta* has *a*, *c*, and *e* linked. As it seems probable that the hexaploid wheats have arisen at some time through a doubling of the chromosomes in a sterile hybrid between a diploid and a tetraploid species, the tetraploid and hexaploid wheats might be expected to have certain chromosomes in common. Whatever the explanation, these apparent linkage phenomena in wheat species are of much interest, and their elucidation may well mark another step in the advance of genetic theory.

Tschermak and Bleier (*Ber. Deut. Bot. Gesells.*, vol. 44, p. 110) have recently obtained a constant fertile octoploid hybrid by crossing *Aegilops ovata* with *Triticum dicoccoides* and *T. durum*. This they believe supports Percival's hypothesis that the hexaploid wheats arose from crosses of *T. dicoccoides* with Aegilops. But Percival (*Jour. Genetics*, vol. 17, p. 60) has found that Aegilops itself contains species with $2n$, $4n$, and $6n$ chromosomes.

Another set of results bearing closely on these problems is derived from the work of Prof. G. C. Meister with his wheat-rye hybrids (*Saratov Agr. Exp. Station*, I, p. 220, 1923). Six generations have been grown from the original natural crosses and a multitude of forms has been obtained, but the 'F_2' consisted of uncontrolled back-crosses with the parents. The parent wheat was hexaploid and the rye diploid, the hybrid F_1 being tetraploid. Chromosome studies combined with genetical examination of the later generations should make possible an analysis of what is happening—whether merely recombination of factors already present or whether germinal changes of various possible kinds are responsible for the appearance of some of the new types. How, from a single species of wheat when crossed with rye, a whole series of wheat species and varieties, some of which are already well known, should arise, is not at present clear; but the elucidation of this problem should add much to our understanding of the relationship between different species of wheat. One of the forms thus obtained is very similar to *T. persicum*, a tetraploid wheat. A full study of the chromosomes in these hybrids may be expected to throw light on the relation between crossing and mutation, and also on the relationships between wheat species.

R. RUGGLES GATES.

The Recolonisation of Krakatau by Animal Life.

THE gradual recolonising of the island of Krakatau with plants and animals subsequent to the catastrophe of 1883 is a subject of great biological interest. Dr. K. W. Dammerman, of the Buitenzorg Museum, tells us that after studying the new fauna of Krakatau it was desirable to compare it with that of some similar neighbouring island which had remained unaffected by volcanic convulsions. After taking various islands into consideration, the nearest suitable *terrains* for such comparison appeared to be Durian—a member of the Rhio-Lingga archipelago. It has about the same area as Krakatau and is situated between the bigger island of Sumatra and the Malay Peninsula (just as Krakatau lies between Java and Sumatra). The whole island is clothed with virgin forest, it has been little interfered with by man, and, for a very long time, no volcanic eruptions have devastated its fauna and flora. The fauna of Durian proved somewhat disappointing, owing to the poor soil and the resulting rather scanty vegetation. No Ficus of any kind, for example, was detected on the island, and, it may be added, trees of the fig tribe are one of the most attractive for birds, insects, and other animals.

Dr. Dammerman states that the research on the fauna of Durian[1] was wholly planned for the purpose of comparing it with that of Krakatau—to ascertain what Krakatau's fauna possibly was before the eruption, and what it is likely to consist of in future. Taking the whole fauna into consideration, he finds that the total number of species of animals on Krakatau at present is about 62 per cent. of that of Durian, but, with regard to individual groups, very different figures reveal themselves. As regards the vertebrates, Krakatau is far behind Durian with 47 per cent.. but considering terrestrial forms alone, and excluding birds and bats, Krakatau has only 21 per cent. of the forms inhabiting Durian. With the invertebrates the poorness of Durian Island is noticeable, as Krakatau already has 93 per cent. of the number of invertebrates of Durian. Of insects only, Durian has a great majority, having about 40 per cent. more than Krakatau.

The remarkable conclusion of Dr. Dammerman's comparison is that Krakatau has regained about 60 per cent. of its normal fauna after a lapse of about forty years, on the supposition that the fauna of Durian is a normal one for the comparison. He maintains that the fauna of Krakatau will be complete, not after centuries, but within a comparatively short time, much shorter than might reasonably have been anticipated. The fauna is likely to become much richer than that of Durian to-day, on account of its more fertile soil and luxuriant vegetation.

Excluding bats, of which certainly many more species will reach Krakatau in future years, nine terrestrial mammals occur on Durian against only one on Krakatau. This species, the common Malay house rat, seems to have come in about 1917, but when the island was revisited in 1924 it appeared to be on the verge of extinction. This conclusion is in accordance with the theory that house rats are unable to thrive away from human dwellings. The field rat, and possibly other species, are to be expected together with the Malay macaque and the commoner kinds of wild hogs. Of the birds, it is anticipated that the fauna will become about twice as rich as it is nowadays, but fresh water being absent on Krakatau, such birds as are dependent thereon will have no chance of survival should they arrive on the island. Among the reptiles, the lacertilian *Lygosoma atrocostatum* is now abundant, whereas in 1921 the species is stated certainly not to have been there, and the same applies to the crocodile. Among the insects, Hymenoptera are not anticipated to show rapid increase of species in the future, but Coleoptera and Lepidoptera are still far from their maxima.

In short, it appears that on new land, carnivorous animals are later invaders than vegetable feeders, and on Krakatau there are as yet no insectivorous bats or other carnivorous mammals, Cicindelidæ, or predaceous flies. Other groups of raptorial insects such as Mantidæ and Neuroptera are rare. The exception appears to be the spiders, which are unusually abundant. This is explained on the basis of the extraordinary ease by which Araneæ are spread, and the fact that they thrive largely on flying insects, which are those which would reach the island early in the process of repopulation.

It is noteworthy that three species of Oligochæta (against two species on Durian) have reached Krakatau, but, as might be expected, there are no freshwater Crustacea or Mollusca, but land members of the two latter groups are represented by three and six species respectively.

A. D. IMMS.

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[1] K. W. Dammerman, "The Fauna of Durian and the Rhio-Lingga Archipelago" *Treubia*, vol. 8, liv. 3-4, July 1926, pp. 281-326.

British Industries Fair.

THE British Industries Fair, which is organised annually by the Department of Overseas Trade, was held on Feb. 21-Mar. 4 at the White City, London. A section of the Fair was held at the same time at Birmingham, mainly for hardware and engineering exhibits. Evidence of the increasing popularity of the London fair was provided by the Department being able to issue a detailed catalogue six weeks before the opening, all the exhibiting space available having been reserved by that date.

The dominating exhibit of the chemical section was arranged by the Imperial Chemical Industries, Ltd., the combine recently formed by Brunner, Mond and Co., Ltd., Nobel Industries, Ltd., the United Alkali, Ltd., and the British Dyestuff Corporation, Ltd. The exhibit was designed to show the wide range of products obtained from raw materials in general use, such as sulphur, coal, brine, and limestone. Nitram, Ltd., a subsidiary company, demonstrated in an interesting way the new principle in use for fertilising grazing land.

Another exhibit of chemical interest was the new fresco medium (silicon ester fresco) which by offering the artist a new medium may revive an ancient art some of the secrets of which have been lost. Silicon ester is said to form as convenient a medium as oil, and to combine the fluidity and facility of water colour with the strength and depth of oil. It is hoped that this discovery will lead to a revival of large mural decorations. The firm interested in silicon ester fresco—Messrs. Albright and Wilson, of Oldbury—are also promoting the use of silicon ester for consolidating and protecting the surface of decaying stone and for imparting a new siliceous face to terra-cotta in the early stages of decay. The silica is deposited in an adhesive and non-crystalline form. Remarkable success has been obtained in the restoration of decayed stone-work in old buildings by the use of this material.

Improvements in the reproduction of sound by gramophone were shown by Messrs. C. Gilbert and Co.—a Sheffield firm—who demonstrated their tone reflector, an instrument for producing great volume of sound without distortion. Among the radio exhibits the Priory loud speaker made by a Newport Pagnell firm deserves a word of commendation.

Several firms exhibited aids for the deaf. The National Institute for the Deaf has strongly advised sufferers to consult an ear specialist to ascertain whether the deafness is of a type likely to be helped by an artificial aid and to deal only with a firm willing to allow a home trial of two or three weeks before purchase. This warning is without doubt necessary, and should be widely advertised to prevent the exploitation of sufferers. Good progress is being made in electrical aids, but older forms of aid are also receiving attention. Mr. Geo. W. King, proprietor of the British Acoustic Co., himself a sufferer, showed some light and comfortable pairs of horns, the use of which by deaf people will probably become more general in future.

Another exhibit of medical interest was the "Magic Blanket," produced by the Radiocoil Electromagnetic Blanket, Ltd., of Manchester Street, London, W.1. This blanket has more than 12,000 feet of specially prepared wire covered with downy material, the inner surface being thickly quilted. Its use is recommended by the makers for sufferers from various diseases. An induction pad is also provided to be used in conjunction with the blanket. This pad gives a rise of temperature in the blanket from 50° to 130° F. in sixty minutes, and profuse perspiration is obtained in forty-five minutes.

The Linguaphone Institute exhibited gramophone records for learning foreign languages. These records reproduce the speech of well-known elocutionists in various languages. The advantages of this simple method of learning foreign languages are obvious, and it is not surprising to learn that the records are used by more than 900 schools, colleges, and universities.

These few notes by no means exhaust the exhibits of scientific interest. The catalogue shows in the section of "Chemical and Allied Products" that a large number of British firms are engaged in the production of chemicals, drugs, dyes, fertilisers, insecticides, perfumes, and photographic materials. Makers of scientific and optical instruments are also well represented.

The Fair was visited by the King and Queen, and attracted a large number of buyers and other visitors.

University and Educational Intelligence.

Cambridge.—Mr. Ramsay, Master of Magdalene College, and Mr. Thirkill, Clare College, have been elected members of the Council of the Senate. Prof. W. J. Dakin, of the University of Liverpool, has been nominated to use the University table at Naples next April, and Mr. J. Gray, King's College, to use the University table at the laboratory of the Marine Biological Association at Plymouth next July.

Edinburgh.—At the meeting of the University Court on Monday, Feb. 21, Dr. R. J. Clark was appointed lecturer, and Carnegie teaching fellow, in the Department of Natural Philosophy.

It was announced that Mr. Thomas Cowan had offered a sum of £15,000, supplementary to previous gifts, in order to enable the University to carry out a projected scheme for providing a residential house for men-students. Mr. Cowan has already given £15,000 to the University, £10,000 of which was contributed in appreciation of the work done by students during the general strike of 1926.

London.—Five addresses, spread over the period February-June, have been arranged as part of the centenary celebrations of University College. The speakers include Prof. E. H. Starling, on "A Century of Physiology" on Feb. 28, and Sir Oliver Lodge, on Mar. 14, at 8.30 p.m., on "A Century's Progress in Physics."

Manchester.—The Council has accepted the resignation of Prof. W. W. C. Topley from the chair of bacteriology and the directorship of the public health laboratory as from September next, when he will take up his duties as professor of bacteriology and immunology in the new London School of Hygiene and Tropical Medicine.

Mr. W. O. Howarth, lecturer in botany, has been appointed to supervise research in mycology under the scheme of the British Empire Cotton Growing Corporation. Mr. H. G. Chippindale has been appointed research assistant in mycology under the same scheme.

Calendar of Discovery and Invention.

March 7, 1785.—Among the landmarks in the history of geology was the publication of James Hutton's "Theory of the Earth: or an Investigation of the Laws observable in the Composition, Dissolution, and Restoration of Land upon the Globe," read to the Royal Society of Edinburgh on Mar. 7 and April 4, 1785. It attracted little attention at the time, but ten years later Hutton published his views in two volumes, and in 1802 Playfair wrote his "Illustrations of the Huttonian Theory of the Earth."

March 8, 1618.—Searching for a simple relation which would connect the distances of the planets with their times of revolution, Kepler found after long calculation that the square of the time in which a planet revolves round the sun is proportional to the cube of the average distance of the planet. This, he said, first occurred to him on Mar. 8, 1618, and two months later he recognised the absolute truth of a principle for which he had been searching for seventeen years.

March 9, 1720.—Halley succeeded Flamsteed as Astronomer Royal.

March 9, 1862.—A fight which revolutionised sea warfare took place in Hampton Roads, U.S.A., on Mar. 9, 1862. The ***Monitor***, Ericsson's famous ship, there met the ***Merrimac***. The ***Monitor***, "a fort upon a raft," carried two 11-inch guns in a revolving turret. The ***Merrimac***, a converted 40-gun frigate, had six 9-inch, two 7-inch, and two 6-inch guns. The fight was in the nature of a duel and was inconclusive, but from that time dates the introduction of the turret, advocated by Ericsson in America and Cowper Coles in England.

March 10, 1809.—Founded in 1807, the Geological Society at first took the form of a dining club, and some members wished that it should be regarded as an assistant association of the Royal Society. This, however, did not meet with general approval, and on Mar. 10, 1809, a resolution was passed "that any proposition tending to render this Society dependent upon or subservient to any other society does not correspond with the conceptions the meeting entertains of the original principles upon which the Geological Society was founded."

March 12, 1683.—Geological maps were first suggested by Martin Lister, who on Mar. 12, 1683, read to the Royal Society "An ingenious proposal for a new sort of Maps of Countrys, etc."

March 12, 1782.—Watt's grand improvements in the steam engines were set down in four patents. His first patent contained the important inventions of the separate condenser and air-pump; his second describes devices for obtaining rotary motion. The date of the third patent is Mar. 12, 1782, and in this he makes a claim for a double acting engine and for using the steam expansively. To these several improvements he added the throttle valve, the parallel motion, the centrifugal governor, and the indicator.

March 12, 1884.—Two pioneers whose efforts gave a great impetus to the utilisation of electric energy were John Dixon Gibbs and Lucien Gaulard. In Paris in 1881 they produced a "secondary generator," an improved form of which was patented on Mar. 12, 1884. Their system of distribution was used in London in a portion of the Metropolitan Railway, and also for lighting Regent Street and Oxford Street. Though when judged by present-day standards their secondary generators appear crude pieces of apparatus, they were the forerunners of the present-day transformers. E. C. S.

Societies and Academies.

Paris.

Academy of Sciences, Jan. 24.—**E. Goursat**: A problem of the theory of surfaces.—**F. E. Fournier**: The inclination θ, always favourable to the speed of a ship, that its satellite wave gives to its plane of flotation, in a calm sea.—**F. W. Perkins**: The resolution of the problem of Dirichlet.—**André Roussel**: The ensembles of equally continuous functionals.—**G. Sugot**: The gyroscopic movement of a projectile.—**P. Dejean**: The influence of compression on the fragility of steel. The existence of a limit of fragility.—**Léon Bouthillon**: The inclination of [electromagnetic] waves and directed systems.—**E. Brylinski**: The relative velocity of the earth and the neighbouring ether. A. Picard and E. Stahel have described the results of experiments which they regard as opposed to the conclusions of Miller, based on experiments at Cleveland and at Mount Wilson. The author shows that the two series of experiments, regard being had to the possible errors, are really in agreement.—**Léon and Eugène Bloch**: The spark spectra of bromine. A list of lines in the E_1 and E_2 spectra between wavelengths λ6353 and λ2338.—**Paul Riou**: An apparatus for measuring the rates of absorption of gases by liquids. A description, with diagram, of an apparatus for determining the rate of absorption of a gas by a liquid.—**Mario A. da Silva**: A new determination of the period of polonium. The method is based on the determination of the ionisation produced in pure argon by the α-rays of polonium: the period found is 140·2 days.—**J. Huggett and G. Chaudron**: The temperatures of magnetic transformations in the system iron–ferric oxide.—**Jolibois and Chassevent**: An apparatus for the thermal analysis of plaster. Details of a calorimetric method which gives the velocity of hydration of plaster of Paris, capable of controlling and classifying commercial products more conveniently than by chemical analysis.—**P. Job**: The cuprammonium ion and its stability. Determinations of the equilibrium constant under varying conditions show that the $Cu(NH_3)_4$ ion is the only ion stable at the ordinary temperature.—**Marcel Delépine**: The oxidation with permanganate of pyridine and the pyridine nucleus. The pyridine nucleus is readily oxidised by acid permanganate solutions, the nitrogen appearing mainly as ammonia with some as nitric acid.—**Marcel Godchot and Pierre Bedos**: The action of organo-magnesium compounds on the oxide of cycloheptene. Cycloheptene oxide is isomerised by the action of CH_3MgI, and the cycloheptanone thus formed (suberone) then reacts with the magnesium compound in the ordinary manner.—**V. Hasenfratz**: The preparation and properties of *l*-arabonic and *l*-ribonic lactones.—**L. Royer**: The regular joining up of cubic salts on mica.—**N. Menchikoff**: The crystalline and volcanic rocks of the centre of the Libyan desert.—**Léon W. Collet and R. Perret**: The geology of the Col d'Anterne and of the Cirque des Fonts (Sixt Alps, Haute-Savoie).—**Albert Baldit**: Magnetic measurements in the south-west of the Central Massif.—**K. Tsukamoto**: The transparency of sea water for the extreme ultra-violet. From experiments on synthetic salt solutions, it is concluded that absorption in the extreme ultra-violet by sea water is due to the presence of small quantities of bromides.—**Pierre Allorge**: The vegetation of the sphagnum peats of Galiad (Spain).—**L. Blaringhem**: The affinities of the wild wheats *Triticum ægilopoides* and *T. monococcum*, demonstrated by their reciprocal hybrids.—**Emile André**: A new and abundant source of trilaurin; the seed of the Mahuba, *Acrodiclidium Mahuba*. Of the family of the Lauraceæ, this seed contains about half its weight of a fat consisting of fairly pure trilaurin.—**H. Lagatu and L. Maume**: Control of the mode of nutrition of a perennial plant (vine) in a given soil receiving a given manure.—**Henri V. Vallois**: The variations of the spinal muscles in the higher primates.—**P. Vignon**: The primitive nervation of the wings of insects and the changes from the original plan in the Orthoptera.—**Jules Amor**: Observations on biological similitude.—**Georges Bourguignon**: Double innervations in the human organism, discovered by pathological and normal electrophysiology and controlled by anatomy.—**Henri Piéron**: The law which connects the surface of the wings with the weight of the individual in the same animal species, and some problems concerning the flight of insects. The wing surface in one species studied (*Libellula sanguinea*) is a linear function of the weight supported.—**G. Lefrou**: The anticoagulating power of certain dyes and organic arsenic compounds.—**Raymond-Hamet**: The point of vascular attack of the ergot alkaloids.—**André Bonot and Théophile Cahn**: The estimation of arginine in pure proteids and tissues by a modified Jansen method.—**E. Roubaud and J. Colas-Belcour**: The action of diastases in determining the eclosion of the egg in the mosquito of yellow fever (*Stegomyia fasciata*).—**Bordier**: General principles and technique of the new treatment of Heine-Medin's disease (infantile paralysis).

Brussels.

Royal Academy of Belgium, April 10, 1926.—**P. Stroobant**: Report of the work done by the National Committee of Astronomy during the year 1925.—**P. Teilhard de Chardin**: Some new mammals from the Belgian Tertiary.

May 4.—**Paul Stroobant**: Note on the discovery of two new minor planets at the Royal Observatory, Uccle.—**A. Demoulin**: Determination of the differential invariants and integral invariants of surfaces for the conformal group.—**A. Demoulin**: The method of the mobile birectangular trihedron and some of its applications.—**A. Demoulin**: The surfaces of Guichard.—**Maurice Nuyens**: The electrodynamics of bodies in motion.—**Constant Lurquin**: The stable algorithms of probability.—**Marc de Hemptinne**: Latent heats of evaporation. The formula proposed by Maurice Prud'homme, $\log L = \log a + n \log (T_c - T)$, in which L is the latent heat of evaporation, T the absolute boiling-point under atmospheric pressure, T_c the critical temperature, and k, a, and n constants, has been compared with experimental data for water, ammonia, pentane, hexane, heptane, octane, carbon tetrachloride, chlorobenzene, fluorenzene, benzene, methyl and ethyl acetates, and methyl alcohol, and shown to be generally applicable.—**W. Mund and J. d'Olieslager**: The kinetics of ozone formation under the action of the α-particles. For a given intensity of irradiation by α-particles, ozone is formed with constant velocity, and at the same time is destroyed with a velocity proportional to its concentration.—**J. Errera**: The polarisation of a medium and its molecular structure. The cases of benzene and cyclohexane. From the experimental work described it is concluded that neither of these hydrocarbons has a permanent dipole.

June 5.—**G. Cesàro**: The formula of some Vesuvian silicates.—**Edm. van Aubel**: The viscosity of liquid chlorine. According to A. J. Batschinski, the specific volume of a normal liquid is a linear function of the fluidity. The experimental data of E. W. R. Steacie and F. M. G. Johnson and of Maurice Jellaton on the viscosity of liquid chlorine are shown to be in agreement with Batschinski's formulæ, except for the temperature, $-33 \cdot 8°$ C., in the neighbourhood of the boiling-point.—**Edm. van Aubel**: The viscosity of fused salts. The viscosities of fused salts (silver nitrate, potassium nitrate, lithium nitrate, sodium nitrate, silver chloride, bromide, and iodide) given by various authors, are all in agreement with Batschinski's formula.—**M. Dehalu**: The movement of the perihelion of mercury deduced from certain laws of gravitation.—**Th. De Donder**: A contribution to the electromagnetic tensor and to the mechanical force of Maxwell-Lorentz.—**A. Demoulin**: The method of the mobile birectangular trihedron and some of its applications.—**Georges Homès**: The ionisation of gases and Saha's equation.—**R. Moens**: An ionisation phenomenon of mercury vapour under low pressure.—**Mlle. A. Binard** and **R. Jeener**: Researches on the morphology of the nervous system of the annelids.—**Henri Fredericq**: Demonstration, by chronaximetric measurements, of the direct bathmotropic action of the extrinsic nerves of the heart.

CALCUTTA.

Asiatic Society of Bengal, Jan. 3.—**J. H. Hutton**: (1) A Naga Hills celt. Description of a unique specimen found at Nichuguard, at the foot of the Naga Hills. It is a stone adze of a new type; the material is fossilised (silicified) wood and it is presumably local in origin. (2) Some megalithic work in the Jaintia Hills. There is some connexion between stone-erecting and water. Megalithic bridges exist near Maput village and across the Um-nyakaneh River. The abandoned European Inspection Bungalow near Syndai is locally attributed to ancient native origin. There are rock-cut tanks near the Am-sorai stream and dolmens and slabs near the Am-lubon River. There is some similarity between the Syntengs and Manipuris and Ao Nagas.—**Jayme Ribeiro**: The caves of Sewri. Bombay is rich in natural cavities and fairly large caves are to be found in the vicinity of this city. The caves as yet discovered skirt the eastern coast line of the Island from Jackeria Bunder to a point a little to the north of the Sewri cemetery, both on the east and west of it. More will no doubt be found, but only to disappear by being covered over with buildings. Detailed descriptions of two of the caves and a general description of the strata are given.

ROME.

Royal National Academy of the Lincei, Dec. 5.—**U. Cisotti**: Uniformisants of non-uniform functions.—**G. Scorza**: Real algebraics united to groups of finite order.—**L. Cambi** and **L. Szegò**: Constitution and absorption spectra of the iron nitrososulphides. The absorption spectra of compounds containing the grouping $-S \cdot Fe \cdot N_2O_2$ or $-S_2O_3 \cdot Fe \cdot N_2O_2$ exhibit certain analogies to those of the ferric compounds $Fe(N_2O_2C_6H_5)_3$ and $Fe(CNS)_3$. In highly dilute solutions the salt $KS_3\ Fe_4(NO)_7$ gives spectra indicating the presence of ferrous iron, just as is the case with $FeSO_4 \cdot NO$. The absorption of light by the above nitrososulphides reveals no characteristic justifying the view that these compounds contain univalent iron.—**L. Rolla** and **L. Fernandes**: A new element: Florentium (atomic number 61). A copy is given of a communication preserved under the seal of the Academy since July 4, 1924, and priority claimed for the discovery and naming of this element.—**F. Sacco**: The question of the age of the ophitiferous argillaceous shales of Appennino.—**B. Finzi**: Relative kinetic energy.—**G. Vranceanu**: Equations of the motion of an anolonomous system.—**U. Barbieri**: Absolute azimuth of Eremo di Cherasco, on the horizon of Mondovi.—**R. Brunetti**: Existence of the element of atomic number 61. Results obtained in 1924 and kept under seal by the Academy since July of that year deal with the absorption spectra of certain specimens of rare earths. From the character and disposition of a discontinuity observed in the spectral region between samarium and neodymium, the presence in the material of the element of atomic number 61, missing from Mendeléeff's table, is presumed.—**R. Brunetti**: Identification of the element with atomic number 61. This element has been identified by means of the *K* spectrum.—**U. Crudeli**: Electro-magnetic fields having the electric (magnetic) field zero at the circumference and the magnetic (electric) field tangential.—**F. De Carli**: Additive products of sulphur dioxide with aromatic hydrocarbons. Note ii. In addition to the compounds recently described, sulphur dioxide forms with ethylbenzene the compounds $C_6H_5 \cdot C_2H_5,\ SO_2$, melting at $-91°$ and $C_6H_5 \cdot C_2H_5,\ 2SO_2$, melting at $-78 \cdot 5°$; with cymene the compounds $CH_3 \cdot C_6H_4 \cdot C_3H_7,\ SO_2$, melting at $-89°$ and $CH_3 \cdot C_6H_4 \cdot C_3H_7,\ 2SO_2$, melting at $-83°$, and with tetraline the compounds $C_{10}H_{12},\ SO_2$, melting at $-58°$, $C_{10}H_{12},\ 2SO_2$ melting at $-66 \cdot 2°$ and $C_{10}H_{12},\ 3SO_2$, melting at $-70°$.—**G. Magnanini**: The Bohr model and the supposed coloration of the ions. Both experimental results and deductions on the basis of Arrhenius's theory show that the dissociated part of a coloured electrolyte has always the same absorption spectrum as the non-dissociated part. This is not in accord with Bohr's theory, so that either electrolytic dissociation is a spontaneous process having nothing in common with true dissociation as produced, for example, by the spark discharge, or the explanations furnished by Bohr's theory with regard to the intimate constitution of matter are inaccurate.—**C. Capelletti**: The bacteroid form and immunity in leguminous plants.

Pontifical Academy of Sciences, Jan. 16.—**Hagen**: Nebula N. G. C. 1193. Opinions contrary to those of Herschel are shown to be erroneous.—**Hagen**: The surface connected with a curve of space.—**Kaas**: A strange case of hypersensibility.—**Carathéodory**: Theory of analytic functions.—**Zanon**: Diatomaceæ of a Venetian peat.—**Borghesani**: A wine from a wild grape of Central America.—**Borghesani**: Treatments of wine for the celebration of mass.—**Neviani**: *Equorfossa Farnesinæ* Nev.—**A. Marotti**: A noteworthy class of permanent plane motions of a perfect liquid.

VIENNA.

Academy of Sciences, Dec. 9.—**L. Schmid** and **G. Bilowitzki**: Communication on insulin. Molecular weight determinations in phenol showed that insulin is highly polymerised in that solvent.—**L. Gröger**: Coloration and luminescence phenomena in Iceland spar after previous treatment with Becquerel rays.—**E. Lohr**: Additions to the continuity theory of Röntgen-ray propagation in crystals.

Dec. 16.—**A. Haas**: The increase of frequency in light-quanta by impact with swiftly moving particles of matter (see NATURE, Feb. 19, p. 296).—**K. Brunner** and **J. Medweth**: The course of the reaction in Brunner's synthesis of triazol.—**W. Gabl** and **O. Schmidegg**: Derivatives of phenyl-dimethyl-triazol.—**H. Hernler** and **F. Matthes**: The nitrification of phenyl- and naphthyl-triazols.—**A. Kieslinger**: Geology and petrography of the Kor Alps.—**F. Heritsch** and **N. Stücker**: The Mürzzuschlag earthquake of July 6, 1926.

Official Publications Received.

British.

Scientific Reports of the Agricultural Research Institute, Pusa (including the Reports of the Imperial Dairy Expert, Physiological Chemist, Government Sugarcane Expert, and Secretary, Sugar Bureau), 1925–26. Pp. vi+212. (Calcutta: Government of India Central Publication Branch.) 2.8 rupees; 4s. 6d.

Agricultural Research Institute, Pusa. Bulletin No. 165: List of Publications on Indian Entomology, 1925. (Compiled by the Imperial Entomologist and the Offg. Imperial Entomologist.) Pp. ii+62+x. (Calcutta: Government of India Central Publication Branch.) 12 annas; 1s. 3d.

Bath Royal Literary and Scientific Institution. Address delivered on July 10th, 1926, by Dr. F. A. Bather on William Smith, 'The Father of English Geology.' Pp. 14+4 plates. (Bath.) 6d.

National Institute of Industrial Psychology. Institute Report No. 1: Occupation Analysis; the Study of Aptitudes and Attainments necessary for Success in different Kinds of Employment. Pp. iv+36. (London.) 2s.

Foreign.

Department of the Interior: Bureau of Education. Bulletin, 1926, No. 6: Personnel and Organization of Schools in the small Cities (2,500 to 10,000 Population, 1924–25). By Prof. Harry S. Ganders. Pp. iv+36. 10 cents. Bulletin, 1926, No. 16: A Handbook of Educational Associations and Foundations in the United States. Pp. iii+82. 15 cents. Bulletin, 1926, No. 17: Record of Current Educational Publications; comprising Publications received by the Bureau of Education to July 1, 1926. Pp. 41. 10 cents. Bulletin, 1926, No. 20: Higher Education; Biennial Survey, 1922–1924. By Arthur J. Klein. Pp. ii+29. 5 cents. (Washington, D.C.: Government Printing Office.)

Department of Commerce: Bureau of Standards. Scientific Papers of the Bureau of Standards, No. 538: Spectral Energy Distribution of the Light emitted by Plants and Animals. By W. W. Coblentz and C. W. Hughes. Pp. 521-534+2 plates. (Washington, D.C.: Government Printing Office.) 10 cents.

University of California Publications in American Archæology and Ethnology. Vol. 23, No. 3: The Emeryville Shellmound; Final Report. By W. Egbert Schenck. Pp. 147-282+plates 36-54. (Berkeley, Cal.: University of California Press; London: Cambridge University Press.) 1 dollar.

Koninklijk Magnetisch en Meteorologisch Observatorium te Batavia. Verhandelingen No. 18: Typen van den Regenval in Nederlandsch-Indie (Rainfall Types in the Netherlands Indies). Door (By) Dr. J. Boerema. Pp. iii+108+2 maps. (Weltevreden.)

Publikationer fra det Danske Meteorologiske Institut. Meddelelser Nr. 6: Om Isforholdene i Danske Farvande Aarene 1861–1906. (Fortsættelse af Meddelelse Nr. 2). Av. C. I. H. Speerschneider. Pp. 88. (København: G. E. C. Gad.)

Société des Nations: League of Nations. Bulletins de l'Institut International de Coopération intellectuelle: Bulletins of the International Institute of Intellectual Co-operation. Bulletin des relations scientifiques: Bulletin for Scientific Relations. 2me année. No. 1, Février. Pp. 187-228. (Paris: Les Presses universitaires de France.) 8 francs.

United States Department of Agriculture. Department Circular 395: The Oriental Peach Moth. By Alvah Peterson and G. J. Haeussler. Pp. 28. (Washington, D.C.: Government Printing Office.) 10 cents.

Proceedings of the United States National Museum. Vol. 70, Art. 8: Some Braconid and Chalcid Flies from Formosa, Parasitic on Aphids. By A. B. Gahan. (No. 2657.) Pp. 7. (Washington, D.C.: Government Printing Office.)

Catalogues.

Eastman Organic Chemicals. List No. 16, January. Pp. 78. (Rochester, N.Y.: Eastman Kodak Co.)

Artificial Sunlight. Bulletin No. 80, Supplementing Catalogue, Part 8, Section 5. Pp. 46. (London: Watson and Sons (Electro-Medical), Ltd.)

Bulletin of Development covering the Twelve Months ending June thirtieth, 1926. Pp. 31. (London: Adam Hilger, Ltd.)

Century Motors, Single Phase and Polyphase. (List No. A30.) Pp. 24. (London: Swedish General Electric, Ltd.)

International Press Exhibition, Cologne, May–October 1928. Pp. 24. (Cologne.)

Catalogue of Important Works on Gardening and Botany. (No. 148.) Pp. 40. (London: Dulau and Co., Ltd.)

Catalogue de livres anciens et modernes rares ou curieux relatifs à l'Amérique et les régions polaires. Pp. 48. (Paris: Librairie Adrien-Maisonneuve.)

Wild-Barfield Small Electric Furnaces for Works and Laboratories, and for all Purposes requiring the Accurate Maintenance of High Temperatures. Section H. Pp. 16. (London: Automatic and Electric Furnaces, Ltd.)

Diary of Societies.

SATURDAY, March 5.

Royal Society of Medicine (Otology Section), at 10.30 A.M.

Geologists' Association (in Department of Zoology, University College), at 2.30.—Prof. D. M. S. Watson: Demonstration of Some Early Fossil Vertebrates.

Royal Institution of Great Britain, at 3.—Dr. J. B. McEwen: Beethoven (I).

Institute of British Foundrymen (Lancashire Branch) (at Rochdale), at 6.30.—W. H. Poole: The Foundry Cupola.

Institute of British Foundrymen (Birmingham, Coventry, and West Midlands Branch) (at Engineers' Club, Birmingham), at 6.30.—F. J. Cook: Some Experiences in the Production of Malleable Castings.

Hull Association of Engineers (at Technical College, Hull), at 7.15.—H. Hall: Civil Engineering Experiences in South America.

MONDAY, March 7.

Victoria Institute (at Central Buildings, Westminster), at 4.30.—Prof. T. G. Pinches: The Completed Legend of Bel-Merodach and the Dragon.

Royal Institution of Great Britain, at 5.—General Meeting.

Royal College of Surgeons of England, at 5.—Sir Arthur Keith: The Peoples of the East: Past and Present (3): An Account of the Earliest Sumerians so far Discovered, the Description being based on a Study of Human Remains found at and near Ur of the Chaldees by the Joint Expedition of the British Museum and of the Museum of the University of Pennsylvania under the leadership of Mr. C. Leonard Woolley.

Society of Engineers (at Geological Society), at 5.30.—M. E. Gerard: The Raising of a 1250 ton Coal Bunker after a 7-ft. Subsidence.

Institution of Automobile Engineers (Bristol Centre) (at Merchant Venturers' Technical College, Bristol), at 6.45.—H. R. Ricardo: Some Notes on Petrol-Engine Development.

Institution of Electrical Engineers (Informal Meeting), at 7.—Capt. P. P. Eckersley and others: Discussion.

Glasgow University Alchemists' Club (Annual General Business Meeting), at 7.30.

Aristotelian Society (at University of London Club), at 8.—J. MacMurray: The Place of Experiment in Knowledge.

Society of Chemical Industry (London Section) (at Chemical Society), at 8.—Prof. W. E. S. Turner: Recent Progress in the Glass Industry.

British Psychological Society (Education Section, jointly with General Society) (at Royal Anthropological Institute), at 8.—Prof. J. Piaget: La première année de l'enfant.

Institution of the Rubber Industry (London and District Section) (at Engineers' Club, Coventry Street, W.1), at 8.—P. Dunsheath: Some Electrical Properties of Rubber.

Surveyors' Institution, at 8.—Discussion on Leasehold Reform.

Royal Geographical Society (at Æolian Hall), at 8.30.—Rt. Hon. W. Ormsby-Gore: Some Nigerian Contrasts.

Institute of Chemistry (Manchester and District Section) (at Manchester).—Prof. E. C. C. Baly: Plant Chemistry.

TUESDAY, March 8.

Royal College of Physicians of London, at 5.—Dr. W. F. Dearden: Health Hazards in the Cotton Industry (Milroy Lectures) (2).

Royal Institution of Great Britain, at 5.15.—Prof. J. S. Huxley: Problems of Animal Growth and Development (6).

Institution of Petroleum Technologists (at Royal Society of Arts), at 5.30.—Dr. A. Wade: Two Shallow Oilfields in Texas.

Zoological Society of London, at 5.30.—Prof. E. B. Poulton: Gynandromorphism in Butterflies following Shock to the Pupæ.—Dr. H. H. Scott: Report on the Deaths occurring in the Society's Gardens during the Year 1926.—Prof. D. M. S. Watson: The Reproduction of the Cœlacanth Fish Undina.—Dr. R. Broom: (a) On a New Type of Mammal-like Reptile from the South African Karoo Beds; (b) Some Further Points on the Structure of the Mammalian Basicranial Axes.—Dr. N. S. Lucas, E. M. Hume, and H. H. Smith: On the Breeding of the Common Marmoset (*Hapale jacchus* Linn.) in Captivity when irradiated with Ultra-Violet Rays.

Institution of Civil Engineers, at 6.—A. W. Stonebridge: The Tansa Completion Works for the Water Supply of Bombay.

Institution of Aeronautical Engineers (at Junior Institution of Engineers), at 6.30.—Major H. N. Wylie: Portable Hangars.

Institute of Marine Engineers, at 6.30.—W. F. Rabbidge: The M.A.N. Internal Combustion Engine and other Types.

Institution of Electrical Engineers (Informal Meeting), at 7.—Capt. P. P. Eckersley and others: Discussion on Wireless as a Factor in World Communication.

Institution of Electrical Engineers (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—Dr. W. H. Eccles: Address.

Institution of Electrical Engineers (North-Western Centre) (at Engineers' Club, Manchester), at 7.—J. W. T. Walsh: Illuminating Engineering.—H. T. Harrison: The Problems of Public Lighting by Electricity.

Institution of Electrical Engineers (Scottish Centre) (at North British Station Hotel, Edinburgh), at 7.—L. C. Grant: High-Power Fusible Cut-outs.

Royal Photographic Society of Great Britain, at 7.—Annual General Meeting.

Society of Chemical Industry (Birmingham and Midland Section) (Annual Meeting) (at Birmingham University), at 7.30.—H. W. Rowell: The Commercial Synthetic Resins and their Product (Lecture).

North-East Coast Institution of Engineers and Shipbuilders (at Middlesbrough), at 7.30.—G. B. Butler: From Ironstone to Finished Product.

Quekett Microscopical Club, at 7.30.—S. R. Wycherley: A Fortnight in Sark with a Microscope.

Pharmaceutical Society of Great Britain, at 8.—J. E. Barnard: The Microscope and its Use in Research (Lecture).

Royal Anthropological Institute, at 8.30.—R. Firth: The Exchange of Gifts in Primitive Societies.

Institute of Brewing (London Section) (at Engineers' Club, Coventry Street, W.1).

WEDNESDAY, March 9.

Institute of Metals (Annual General Meeting) (at Institution of Mechanical Engineers), at 10 A.M.—Presidential Address.—Prof. D. Hanson and Grace W. Ford: Investigation of the Effects of Impurities on Copper. Part V. The Effect of Bismuth on Copper.—Prof. D. Hanson and C. B. Marryat: Investigation of the Effects of Impurities on Copper. Part III. The Effect of Arsenic on Copper. Part IV. The Effect of Arsenic plus Oxygen on Copper.—C. Blazey: Brittleness in Arsenical Copper.—At 2.—D. F. Campbell: Electric Furnaces in Non-Ferrous Metallurgy, and a General Discussion on Electric Furnaces in Non-Ferrous Metallurgy.

INSTITUTION OF CHEMICAL ENGINEERS (Conference) (at Chemical Society), at 5.—W. C. Freeman: The Production of Dissolved Acetylene and its Application to Lead Burning.—S. J. Tungay: Lead as a Constructional Material in Chemical Engineering.—At 8.—Dr. H. J. Bush and A. Grounds: The Function of the Schmiedel Box in Sulphuric Acid Manufacture.—W. G. Mills: Some Improvements in Chamber Sulphuric Acid Plant.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: The Peoples of the East: Past and Present (4). The Racial Characters of Sumerians and Babylonians and their Relationship to other Peoples.

INSTITUTION OF CIVIL ENGINEERS (Informal Meeting), at 6.—A. H. Douglas: Traverse Surveys.

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Birmingham University), at 7.—J. W. T. Walsh: Illuminating Engineering.—H. T. Harrison: The Problems of Public Lighting by Electricity.

ELECTRICAL ASSOCIATION FOR WOMEN (at E.L.M.A. Lighting Service Bureau, Strand), at 7.—Simple Household Repairs—Fuses, Lampholders, Bells, etc.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section) (at Bolbec Hall, Newcastle-upon-Tyne), at 7.15.—J. H. Frith: Grinding.

ROYAL SOCIETY OF ARTS, at 8.—Dr. E. W. Smith: The Utilisation of Gas Coke.

MEDICAL SOCIETY OF LONDON, at 9.—D. J. Armour: The Surgery of the Spinal Cord and Membranes (Lettsomian Lectures) (2).

THURSDAY, MARCH 10.

INSTITUTE OF METALS (Annual General Meeting) (at Institution of Mechanical Engineers), at 10 A.M.—R. Genders: The Penetration of Mild Steel by Brazing Solder and other Metals.—J. H. Miller: The Penetration of Brass by Tin and Solder, with a Few Notes on the Copper-Tin Equilibrium Diagram.—H. J. Hartley: The Attack of Molten Metals on Certain Non-Ferrous Metals and Alloys.—H. Moore and S. Beckinsale: Notes on the Manufacture and Properties of Hair Springs.—F. Hargreaves: (*a*) The Application of Strain Methods to the Investigation of the Structure of Eutectic Alloys; (*b*) Note on the Crystallisation of the Lead-Tin Eutectic.—At 2.—J. D. Grogan: The Influence of Calcium on Aluminium containing Silicon. With an Appendix on The Estimation of Calcium in Aluminium Alloys, by P. G. Ward.—M. Hansen: The Magnesium-Rich Magnesium-Copper Alloys.—R. Genders: The Mechanism of Inverse Segregation in Alloys. With an Appendix on The Accurate Determination of Copper in Bronze by Electrolysis, by R. A. F. Hammond.—Prof. Kôtaro Honda and Prof. Hikozo Endo: Magnetic Analysis as a Means of Studying the Structure of Non-Magnetic Alloys.—Prof. B. W. Holman: An Etching Reagent for Copper.—Dr. J. Newton Friend and W. E. Thorneycroft: (*a*) Examination of a Fifteenth Century Brass; (*b*) Note on the Silver Contents of Roman Lead from Folkestone and Richboro Castle.

ROYAL SOCIETY, at 4.30.—A. Levin and J. Wyman: The Viscous Elastic Properties of Muscle.—A. Hynd: The Action of Glucosone on Normal Animals (Mice) and its Possible Significance in Metabolism.—Dr. F. W. R. Brambell and Dr. A. S. Parkes: Changes in the Ovary of the Mouse following Exposure to X-Rays.—Dr. A. S. Parkes, Una Fielding, and Dr. F. W. R. Brambell: Ovarian Regeneration in the Mouse after Complete Double Ovariotomy.—A. Walton: The Relation between 'Density' of Sperm-Suspension and Fertility as determined by Artificial Insemination of Rabbits.

INSTITUTION OF CHEMICAL ENGINEERS (Conference) (at Chemical Society), at 5.—B. D. Porritt: Rubber as a Constructional Material in Chemical Engineering.—At 8.—Prof. F. C. Lea: The Effect of Heat on some of the Properties of Metals.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science), at 5.—Dr. G. M. B. Dobson: The Measurement of the Absorption Coefficients of Light Filters.—Ibbs and Underwood: A Comparison of the Behaviour in Thermal Diffusion of Nitrogen and Carbon Monoxide, and of Nitrous Oxide and Carbon Dioxide.—R. R. Nimmo: The Relighting of a Neon Lamp when Momentarily Extinguished at Voltages below the Striking Potential.—D. B. Deodhar: The Electrification of Dust Clouds.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Prof. F. R. Fraser: Cardiac Dyspnoea (Goulstonian Lectures) (1).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. Garstang: The Progress of Hittite Studies (3).

SOUTH LONDON ENTOMOLOGICAL AND NATURAL HISTORY SOCIETY (at Hibernia Chambers, London Bridge), at 7.

INSTITUTION OF ELECTRICAL ENGINEERS (Dundee Sub-Centre) (at University College, Dundee), at 7.30.—G. H. Taylor: The Jubilee Year of the Telephone.

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—B. Graves: Microscopy of the Living Eye.

ROYAL SOCIETY OF MEDICINE (Neurology Section) (at National Hospital, Queen Square, W.C.1), at 8.

HARVEIAN SOCIETY (at Paddington Town Hall), at 8.30.—Sir Berkeley Moynihan: Diverticula of the Alimentary Canal (Harveian Lecture).

OIL AND COLOUR CHEMISTS' ASSOCIATION.

INSTITUTION OF THE RUBBER INDUSTRY (Manchester Section) (at Manchester).—N. Blond: Difficulties of Rubber Proofed Garment Manufacture.

FRIDAY, MARCH 11.

INSTITUTION OF CHEMICAL ENGINEERS (Annual Corporate Meeting) (at Hotel Victoria), at 12.—Sir Frederic Nathan: Some Industrial Developments and the Chemical Engineer (Presidential Address).—At 2.30.—F. H. Rogers: The Cross Cracking Process and Plant.

DIESEL ENGINE USERS' ASSOCIATION (at Caxton Hall), at 3.—P. A. Holliday: High-Revolution Oil Engines.

ROYAL SOCIETY OF ARTS (Indian Meeting), at 4.30.—R. Mather: The Iron and Steel Industry in India.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Prof. F. Schlesinger: Astronomical Photography of Precision (George Darwin Lecture).

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: The Peoples of the East: Past and Present (5). The People of Egypt, Past and Present, and their Position in a Classificatory System.

MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society), at 6.

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section, jointly with Students' Sections of Institutions of Civil and Mechanical Engineers) (at Institution of Electrical Engineers), at 6.15.—A. C. Price: Patents.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—Annual Meeting.

INSTITUTION OF AUTOMOBILE ENGINEERS (North of England Centre) (at The Temple, Dale Street, Liverpool), at 7.—A. F. Evans: Ships' Lifeboat Motors.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—A chat with Mr. B. Lemere on Architectural Photography.

INSTITUTE OF METALS (Swansea Local Section) (at University College, Swansea), at 7.15.—Dr. F. Johnson: The Influence of Oxygen on Copper and other Non-Ferrous Metals.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—J. Wolstenholme: The Design, Construction, and Operation of the Cupola.

INSTITUTE OF METALS (Sheffield Local Section) (at Sheffield University), at 7.30.—L. Lubbock: Oil Fired Furnaces.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. G. Macdonald: The Wall of Hadrian.

OIL AND COLOUR CHEMISTS' ASSOCIATION (Manchester Section) (at Manchester).—Dr. S. Smith: Cellulose Ester Varnishes: their Manufacture, Properties, and Application.

SATURDAY, MARCH 12.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (South-Western District) (at Bath), at 12.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. J. B. McEwen: Beethoven (3).

PUBLIC LECTURES.

SATURDAY, MARCH 5.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. Harcourt: Some Poisonous Snakes of India.

SUNDAY, MARCH 6.

GUILDHOUSE (Eccleston Square), at 3.30.—Dr. C. Delisle Burns: Experimental Religion.

MONDAY, MARCH 7.

KING'S COLLEGE FOR WOMEN (Household and Social Science Department), at 5.15.—Mrs. Rackham: Justice and the Citizen.

UNIVERSITY OF LEEDS, at 5.15.—Dr. T. Slater Price: Photographic Sensitivity.—At 8.15.—Sir Henry Hadow: Beethoven.

TUESDAY, MARCH 8.

SURVEYORS' INSTITUTION, at 5.30.—Major G. H. Scott: The Development of Airship Transport (Lecture).

WEDNESDAY, MARCH 9.

UNIVERSITY COLLEGE, at 5.30.—Sir William Schooling: Photography of Documents: Object and Methods.

THURSDAY, MARCH 10.

UNIVERSITY OF LIVERPOOL, at 4.—Prof. V. Putti: New Conceptions in the Pathogenesis and Treatment of Sciatica (Lady Jones Lecture).

UNIVERSITY COLLEGE, at 5.—Prof. E. A. Gardner: History of Ancient Sculpture.

ROYAL SOCIETY OF MEDICINE, at 5.15.—Dr. C. F. Coombs: Rheumatism—its Causes and Prevention: The Chronic Rheumatic Diseases (Chadwick Lecture).

KING'S COLLEGE, at 5.30.—Prof. C. G. Seligman: The Mind: Anthropology.

SATURDAY, MARCH 12.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: Trading in Ancient Egypt.

SUNDAY, MARCH 13.

GUILDHOUSE (Eccleston Square), at 3.30.—Major W. Tudor Pole: Universalism in Religion, with special reference to the Bahai Faith.

CONGRESSES.

APRIL 20 TO 24.

JOURNÉES MÉDICALES MARSEILLAISES ET COLONIALES (at Marseilles).—Prof. Cantacuzène: The Rôle of the Streptococcus in the Etiology of Scarlet Fever.—Dr. Mayer: Recent Advances in the Treatment of Cancer.—Prof. Ottolenghi: Malaria.—Dr. N. Bernard: Beri-beri.—Prof. Imbert: Bone-grafting.

APRIL 25 TO 28.

GERMAN SOCIETY FOR INTERNAL MEDICINE (at Wiesbaden).—Discussions on Psychotherapy, introduced by Gaupp and Fleischmann; Results of Recent Functional Investigations of the Stomach and Duodenum, introduced by G. Katsch.—A joint meeting with the German Röntgen Society will be held on April 28, with a discussion on the Significance of Röntgen-ray Examination of the Lungs and Mediastinum for Internal Medicine (excluding Tuberculosis), introduced by Dietlen, Assmann, Haenisch and Lorey, and Fleischner.

SATURDAY, MARCH 12, 1927.

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Pestalozzi and the Teaching of Science.

JOHANN HEINRICH PESTALOZZI died at Brugg, Switzerland, on Feb. 17, 1827; and in the hundred years which have passed since then, a great change has taken place in educational thought and practice. Especially is this so in the province of school science, a growth almost entirely of the latter part of the nineteenth century. But as with all growths, we must search for the roots in the history of a far earlier period than this; and then we discover what science teachers owe to the pioneers of old, one of whom, Pestalozzi, will always hold an honoured place.

During the Middle Ages, when Aristotelian doctrines dominated intellectual thought and the grammar schools in England were precluded by their statutes from teaching any but grammatical subjects, there were already many people alive to the fact that a knowledge of science would be of advantage to the rising generation. They were not, however, thinking of science as we understand it to-day; all they advocated was a study of the scientific works of the classical authors, and by the middle of the seventeenth century a few, but very few, schoolmasters endeavoured to emphasise books of this nature.

Following the rise of modern science, and about the time of the foundation of the Royal Society (1662), a few pioneers urged a reform of the school curriculum in the direction of science teaching. But whether it was Comenius in his wide embracing encyclopædic fashion urging complete reform, or Milton and Cowley advocating a closer study of scientific Latin and Greek books, or Hartlib and Petty emphasising the need of school science of a practical nature, little success attended their labours. Their schemes were all premature; the English grammar schools were not allowed by law to teach science until 1840.

A hundred years after the beginning of the scientific movement came Rousseau, with his vigorous revolutionary doctrines, bent on making his Émile a model youth. The old order was to be swept away and Émile's education was to proceed on novel lines. Amongst other things he must learn science, not book science, but practical, everyday science. No pedant was to teach him, he must teach himself: "Let him not be taught science, let him discover it." No book for Émile but that of the world, for books "only teach us to talk about things we know nothing about." Wordiness in education must disappear, and in its place come things, a first-hand acquaintance with things, so bringing into use the boy's powers of observation, reasoning, and invention.

At the time, in 1762, when "Émile" was published, Pestalozzi was a student at the University of Zurich. He was enraptured with the book, and became ensnared in the revolutionary ideas of his hero Abandoning in turn his course of study for the ministry and for the law, he turned to farming, where his idealism was rewarded with bankruptcy. He then became schoolmaster, a profession he was to follow until his death in 1827.

In this short article we are not concerned with his general views on teaching or with the methods he devised or adopted. It is enough to say that he believed that the true basis of knowledge was sensory experience, and that education should be based on personal, first-hand observation. Out of this grew the familiar object lessons of the nineteenth century, and these are of great significance in the history of science teaching. For during them much scientific information was imparted to the children, since Pestalozzi and his numerous followers took for the subject matter familiar and interesting objects. The pupils learnt to look at things more closely, to examine plants, animals, and inanimate objects. Pestalozzi, it may be recalled, had had experience in farming, and it seems highly probable that in the lessons he himself gave, agricultural topics would frequently be mentioned. Occasionally excursions were made into the surrounding districts, when, under the supervision of the teacher, many interesting titbits of natural history were learnt. But unfortunately this science, if such it can be termed, was taught generally without plan and was of a haphazard nature. It was largely of the demonstrative type, where the attention of the child was directed to some particular part or property of the object, the name of which, when given by the teacher, was repeated aloud and memorised. Such lessons had for their chief function the teaching of words, not science.

In addition, however, to the smattering of scientific information which he gave in this manner, Pestalozzi included physics and chemistry in the curriculum of the school at Munchunbuchsee, and, in the "Report to Parents," special mention was made of science teaching, thus:

> "We are also trying at the same time to organise the teaching of experimental science. So far we have demonstrated to the boys the principal facts concerning Electricity and Magnetism and the behaviour of certain gases. We are, in this connection, trying to establish a satisfactory course of instruction in the language of physical science. A local doctor gives weekly lessons in this direction to the older children with the aid of excellent apparatus in his possession."

Natural history was also taught, for, as he pointed out, almost every child is sure to be familiar with "half a dozen mammals, and as many birds, fishes, insects, amphibians, and worms." In short, he endeavoured to connect the course with the things the boys could see around them, such as the behaviour and structure of the common animals and plants.

All this Pestalozzi was doing, whilst in England and most other countries little, if any, attention was being paid to science in the schools. It is rather significant that many schools, when first introducing science, did so in a similar manner. For example, Dr. Arnold, of Rugby, persuaded the boys to collect specimens of rock, etc., from their neighbourhood to form a science museum, and his successor, Dr. Tait, invited a local physician to give lessons similar to these suggested by Pestalozzi.

The latter had no misgivings on how science should be taught, as the following extract from "How Gertrude Teaches Her Children" shows:

> "All science teaching that is dictated, explained, analysed by men who have not learnt to think and speak in accordance with the laws of Nature, all science teaching of which the definitions are forced, as if by magic, into the minds of children, like a *Deus ex machina*, or rather are blown into their ears by a stage prompter, so far as it does, this must necessarily sink into a miserable burlesque of education."

Pestalozzi's influence on science teaching rests, however, on his object lessons, for they were widely imitated in England, largely owing to Dr. Mayo and his sister. After Dr. Mayo's return from visiting Pestalozzi he opened a school at Epsom and later at Cheam, and in time the Home and Colonial Infant School Society's training college resulted. Here intending teachers were trained to give these object lessons. Further, the two Mayos published books on methods of teaching, the most important for our present purpose being Miss Mayo's "Lessons on Objects." In it were given typical object lessons on numerous scientific subjects, and these served as models to numerous teachers. Lessons of this type became very common in England, especially in the elementary schools, and for many years, in fact until the introduction of Lowe's Revised Code in 1861, they were the only means by which children at such schools were brought into touch with science. But the lessons departed from the model of Pestalozzi, and readers of Dickens will recall the type of lesson Bitzer of "Hard Times" had to endure with his "Quadruped, graminivorous forty teeth, etc.," or the one Nicholas Nickleby caught Squeers giving.

Pestalozzi's influence was not confined to the elementary schools, however, and many secondary schools taught object lessons often with the idea of giving scientific information. Thus, from its foundation in 1832, University College School, London, made use of Miss Mayo's book on "Lessons on Objects," but not for long, since it was found, as Dickens saw later, that these lessons tended to degenerate into a mere explanation of hard words, and hence they were soon discontinued at this school.

Yet though Pestalozzi did little to establish modern school science—the science of his day was not sufficiently organised to serve as a school subject, whilst he himself was chiefly interested in young children—his name must be revered by science teachers because of his patient research into better methods of teaching.

The Industrial Revolution.

Health, Wealth and Population in the Early Days of the Industrial Revolution. By M. C. Buer. Pp. xi + 290. (London: G. Routledge and Sons, Ltd., 1926.) 10s. 6d. net.

THE author of this book is lecturer on economics in the University of Reading. The work is one which, in our opinion, is of first-class importance, written in a most interesting style, and we heartily commend it to all our readers. It is difficult within the compass of a review to give an adequate idea of the value of its contents. It deals with a subject which has caused acute controversy, and still awakens intense emotion in the minds of many of our countrymen—namely, the so-called industrial revolution. Although the author approves of the use of this term, and indeed states that the industrial revolution was of such magnitude as to dwarf all political revolutions, yet we think that the word revolution is misapplied in this case. This word has always been held to denote a violent upheaval and overturning of the social order by insurgence from within; but the industrial revolution was merely an extremely rapid evolution due to purely natural causes, as the author convincingly shows; and it had declared itself, shown all its characteristic features, and accomplished much of its course before any political change took place at all.

The popular conception of this change, which still figures largely in Socialist literature (we remember hearing it expounded with great vehemence by the late Mr. Hyndman in 1890), was that it involved the seizing of the common land of the poorer people by the landlords, whilst the dispossessed were then transformed from freeholders into tenants-at-will or driven into the towns, where they were 'exploited' at starvation pay by greedy manufacturers. It was, so far as we can recollect, Dean Inge who first forced on public attention the fact that this change was accompanied by an enormous and rapid increase in our population. The Dean's estimate was that the population of England had increased by 30 per cent. between 1700 and 1800, and by 300 per cent. between 1800 and 1900; it is with the causes and time of beginning of this increase that our author first sets herself to deal.

The first census of England was made in 1801, but various sources of information exist from which fairly trustworthy estimates of the population at earlier dates can be made. The author weighs the evidence, and comes to the conclusion that at the beginning of the eighteenth century the population of England was 5¼ millions; that it decreased during the first decade and then began to rise, and that it showed a net increase of one million by 1750, but that between 1750 and 1820 the population doubled itself. The rapid increase therefore began long before the invention of the steam engine, and before the expansion of manufacturing industries. It must obviously have been due either to immigration, or to an increase in the fertility of marriage, or to a fall in the death-rate. The author proves that the last was the real cause, and that it was not an increase on the longevity of adults which took place, *but a fall in the infantile death-rate*. She goes on to show that amongst primitive peoples population is regulated by an appalling wastage of child life. Persia, for example, is a country without motors, railways, or manufactures; there is widespread peasant proprietorship and few large towns—yet in some districts 85 per cent. of the children die before attaining the age of ten years, and in other districts only one child in ten attains maturity. In this, man resembles the lower animals, for the greater part of 'natural selection' takes place at the expense of the young.

Now in the sixteenth, seventeenth, and eighteenth centuries, but especially during the first two, England was ravaged by diseases formerly supposed to be tropical. The exact nature of some of these was obscure, because distinct diseases were confounded together under the name of plague, but bubonic plague, typhus, typhoid, dysentery, malaria (ague), and above all, smallpox, were rampant. Smallpox attacked chiefly the young, and few children escaped it. About the middle of the eighteenth century, inoculation as a remedy was introduced, to be followed soon afterwards by vaccination. The author shows that inoculation was in most cases an effective and not very dangerous remedy, since it was performed with an attenuated virus, and in one respect it excelled vaccination, because it was never necessary to repeat it.

Thus the main reason for the increase was the gradual improvement of medical science, but this was coupled with the better development of agriculture and a regular and more nutritious supply of food. Food began to be grown for trading with other districts, not merely for the support of a particular district; this was rendered possible by the development of better roads. The author throws scorn on the idea that the medieval peasant proprietor lived under idyllic conditions. He was miserably housed, and he worked for unthinkable hours for a pittance. When the harvest failed there was no means of bringing food from elsewhere, and the peasant starved, or died from diseases which attacked him owing to his weakened condition brought on by eating rotten grain. One of the diseases which decimated the population was scurvy. Since there was no means of feeding cattle during the winter, the majority were slaughtered every autumn and their flesh salted. The stringency of the game laws is said to have been due to the determination of the feudal lords to avert scurvy by having fresh meat during the winter, so they alone were allowed to hunt game and to keep pigeons. But in the middle of the eighteenth century root crops were introduced from Holland, and thereafter cattle were kept alive during the winter.

The common on which the peasant had grazing rights and from which he collected firewood was unenclosed waste. The author gives a vivid picture of how incredibly large and unproductive this waste was when enclosure began. Agriculture could only be improved by bringing a large part of it under cultivation, and there is no evidence to show that this enclosure was detrimental to the peasant. For when really productive farming began there was regular employment for more men, and a comparison of villages in districts with and without enclosure shows that the population increased faster in the former than in the latter. What the peasant hated was a change in his habits; he preferred to starve under old conditions to which he was accustomed rather than to prosper under the new ones.

The author emphasises the fact that during the eighteenth century, though there was little political liberty as embodied in the right to vote, there was abundant personal and intellectual liberty. To the freedom of initiative, to the prevalence of the doctrine of laissez-faire—in a word, to private enterprise—she attributes the major part of the influences which produced modern England.

At the beginning of the century Northumberland was as wild and unenclosed as the backwoods of Canada, and the enterprising farmers who settled in its valleys, cleared the timber, and brought the ground under cultivation were as truly adventurous pioneers as the merchant adventurers of Queen Elizabeth.

Of course, as the steam engine came into use our manufacturing capacity increased enormously, and there was a steady drift into the towns which has continued ever since. A favourite theory has been that the peasants were lured from their healthy homes in the country into the slums of the towns, where they rotted and died. Now the author shows that the medieval city was in reality a festering sore. To contemporary writers cities were known as devourers of population. Our cathedrals, so beloved by the medievally-minded amongst us, arose in the midst of narrow, unspeakably dirty lanes from which air and light were shut out by overhanging upper stories, with no sewers except an open drain in the middle of the street, into which all rubbish, including human excreta, was flung from the windows. Herds of pigs wandered about fattening on this garbage, and proposals of the rich to pave the streets and remove the rubbish were resented by the poor as an invasion of their privileges. Truly the medieval circle of ideas which the reactionaries would restore if they could, was one of dirt and primitive superstition. But in the eighteenth century, when the drift to the towns began, advancing medical science had begun to discover the necessity for a better water supply; the streets were wider and better paved, and the garbage was removed. Far from perfect as the habitations of the work-people undoubtedly were, they were better than the dwellings they left behind in the country, and population grew in the towns by increase of births over deaths.

The myth that the workmen were 'exploited' by the payment of scandalously low wages is also exploded by the author. As she says, there never was a time when native talent and initiative amongst the workmen had greater opportunities. Early machinery was costly, wasteful, and constantly breaking down, and workmen with skill, common sense, and adaptability could practically demand their own price. Those who got the minimum wage and deserved no more were those who were only fit for routine operations. Just as daring private enterprise built up our agriculture, so it founded our manufactures. On it all England's greatness is founded, and by it, though sorely hampered and embarrassed, we still are borne.

The perusal of this book leaves us with some curious reflections. This unspeakably filthy medieval society from which we have slowly emerged succeeded to a Roman civilisation—a civilisation with paved roads carved with superb engineering across hill and dale; with properly constructed sewers, and with a plentiful supply of pure water carried on wonderful aqueducts. Houses were provided with 'central heating' on much the same plan as that now to be adopted in Liverpool Cathedral, and above all, with properly constructed baths. This civilisation can be traced through Rome to Greece and back to Crete, and possibly eventually to Egypt.

Yet this age-long civilisation, which must have appeared to its contemporaries as securely founded and permanent as the orbit of Nature itself, succumbed to the attacks of northern barbarians, and not until the middle of the nineteenth century did we reach the same level as that achieved by Rome. Washing was eschewed in the Middle Ages as a heathen luxury. So late as 1801 a London doctor stated that his patients amongst 'ladies and gentlemen' washed their hands every day, but did not wash their bodies from year to year. The Anglo-Saxon St. Dunstan is said to have given proof of his holiness by the fact that when he shook his sleeves as he sat at board, 'maggots' escaped from them.

The Mediterranean civilisation once penetrated to the south of Africa. Like the Roman civilisation in Britain, it was overwhelmed by barbarians, and its remains, overbuilt by the kraals of Kaffirs, are to be seen until this day. Our twentieth-century civilisation, if the private enterprise which upholds it is undermined, might suffer a like fate.

E. W. M.

The Empty Quarter.

In Unknown Arabia. By Major R. E. Cheesman. Pp. xx + 447 + 32 plates. (London: Macmillan and Co., Ltd., 1926.) 25s. net.

OF the excellence of Major Cheesman's journey into the deserts of eastern Arabia there can be no question. He travelled down the Persian Gulf from Basra to Bahrain, and from there to the little port of Oqair, on the Arabian coast; there he met camels, sent down for him by the ruler of eastern Arabia, Abdul Aziz ibn Saud, whom he had already met, and to whom he carried a personal letter from Sir Percy Cox. The camels took him, his baggage, and his Baghdadi servant to Hufuf, an oasis which has already been visited by several European travellers. The purpose of the expedition was to collect mammals and birds, and, where necessary, to fix the position of places astronomically, and to make compass traverses when passing over unmapped routes; the traveller's purpose was to work his way south from Hufuf towards the empty quarter of Arabia, unvisited by Europeans, unknown to most Arabs, and only recently brought under the suzerainty of the conquering ibn Saud, leader of the Wahhabis.

Cheesman was delayed nearly three months in Hufuf in mid-winter; he occupied his time collecting the fauna and making a map as unobtrusively as possible, but he was handicapped by the season, for the resident birds were not breeding, and there was no through migration; the insects were presumably hibernating, if we may judge from his scanty collection and from what we know of their behaviour at the same season in Mesopotamia.

At length, on February 8, he left Hufuf and travelled 150 miles south over unknown country, most of it hard desert of an extreme type, until he reached the wells of Jabrin. He is the first European to see the Al Murra Arabs at home; he has brought back a route map, and established the position of the Wadi Sahba, which is now dry at all seasons, but formerly carried water from the highlands of western Arabia right across the peninsula to the Persian Gulf. He has also brought home a good collection of birds and mammals, and of observations on their habits, and a number of specimens of insects, plants, and rocks.

So much for the journey, already described in the *Geographical Journal*. The present book is delightful when it describes the author's observations on bird, beast, or man, and the conclusions which follow immediately from them. There is, for example, an excellent chapter on the water supplies of desert animals, though we think that the author is too much inclined to look for actual water in the form of dew, and that he does not realise the high proportion of water which is held in fragments of dry vegetation. There are also some most interesting notes on gerbilles of the genus Meriones, which prove to be diurnal, and not nocturnal like other gerbilles. We think that the author could have written a book of more permanent value had he included a general account of Nature in Mesopotamia and the islands of the Persian Gulf; he knows more about these countries than any other field naturalist, and he has wandered over them in all directions and at all seasons, collecting and observing. The raw materials for such a study are available in a long series of systematic papers by various specialists in the *Jour. Bombay Nat. Hist. Society*. The present book contains no reference to any of the author's previous travels, except a reprint of an account of a journey along the shores of the Gulf from Oqair to Salwa, and for this reason is a little unsatisfying. So far as the last journey is concerned, the unknown country covered was between Hufuf and Jabrin, and that journey only occupied a fortnight; the same featureless track was covered twice, and a general account of it would be easier to read than the transcript of diary which is given. But even as it stands the book is full of life and vigour and observation, and it makes delightful reading.

When the author gets away from his own observations, however, his zoology becomes surprisingly 'loose.' One may quote his own italicised sentence: "*I think the development of a colour as evidenced most clearly in a subspecies is the result of an influence which I will call subspecific desire, operating through generations of that subspecies, for that particular tone.*" It is clear from the context that he does, in fact, attribute the colour of animals to volition, and that the exercise of the will is thought to be most potent when the bird is nesting, except that predatory species do their 'wishing' when they are stalking their prey.

With regard to protective coloration, the author is strictly orthodox, so much so that he brings forward no fresh arguments in favour of the theory; instead of doing so he talks in general about willow grouse, and mallard, and desert birds, and trout, and lizards, and nightjars (which almost shut their eyes, because they know how conspicuous the eye would otherwise be!). Every one admits that the majority of desert animals, in the widest sense of the word, are coloured so that they resemble the soil on which they are found; in some cases the degree of resemblance is very high, in many much less so; but the theory that this similarity of colour is *protective* is not generally accepted nowadays, because it does not appear to cover more than a fraction of the facts. It is difficult to apply it to the strictly nocturnal animals, and still more difficult to fit it to the subterranean pocket gophers of California and Arizona, and other subterranean mammals and reptiles, many of which exhibit a high degree of resemblance to the soil in which they live. Moreover, if the facts are faced without prejudice, it will be found that a proportion of diurnal desert creatures are black, and this is true in the Old World, America, and Australia; examples occur in birds, and grasshoppers, beetles, flies, and other creatures.

The devout believer in protective coloration will tell us that none of these black creatures needs protection, and that explanation is enough for him; but those who are inquisitive, perhaps agnostic, may reasonably ask why all the creatures which do not need 'protection' should agree to wear black. Even among the facts recorded by Cheesman himself, one can find examples of animals to which the theory of protective coloration cannot be applied. In Arabia, and in many parts of the Old and New World deserts, the bats are much more sand-coloured than their relatives in other climates; moreover, this tendency, which is observable in the less extreme deserts—for example, Mesopotamia—is increased in the intense climate of Hufuf and other similar places. It appears that nothing but an act of faith could carry the true believer over such an obstacle as this, for we can scarcely suppose that a pale bat is protected from a (hypothetical) owl, or that its paleness assists it in pursuing moths (also 'protected') by moonlight.

We understand that the author left for Abyssinia before the book passed through the press, but that does not explain the multitude of inaccuracies which it contains. He was probably wise to adopt a simple system of transliteration from Arabic, suited to the general reader, but his use of it is quite inconsistent. For example, he writes *suq* and *booma*, though both have the same long *u* in the original tongue; on the other hand, he writes *suq* and *burr*, using the same English vowel to represent different sounds. He commonly transliterates the Arabic letter *Khe* by *Kh*, consistently with general usage, but he also uses *k* in 'Jebel Akdhar,' and *h* in 'Hashm.' "The ibn Shaikh" is an unnatural mongrel between the English "The

Shaikh's Son," and the Arabic "Ibn esh Shaikh." One gathers that when Cheesman bade farewell to the Amir at Jabrin, both were so much overcome that they forgot their grammar; one said "we am so pleased you came," and the other chorussed, "I are so pleased to have met you." Neither 'Brinjal' nor 'Jird' are words known to the educated English reader, and as one is Hindustani and the other Persian, there seems no justification for their use here, particularly as English equivalents of both are available.

The illustrations from the author's photographs are admirable, and they serve to show what excellent results may be obtained with a minimum of apparatus and trouble. They were all obtained with a quarter-plate Kodak, and the films were developed four months after they were taken, in England. The scientific results of the expedition have been dealt with by specialists, and their accounts are all reprinted as appendices; the result is that all that is known of the fauna of this part of the world is contained in this one volume. There is an adequate index and an excellent map, reprinted from the *Geographical Journal.*

PATRICK A. BUXTON.

British Optical Science and Industry.

(1) *Proceedings of the Optical Convention, 1926.* Part 1. Pp. x+491+v+26 plates. Part 2. Pp. viii+493-1051+v+23 plates. (London: The Optical Convention, 1 Lowther Gardens, 1926.) 2 vols., 60*s.* net.

(2) *The Optical Convention, 1926. Catalogue of Optical and General Scientific Instruments.* Pp. x+326. (London: The Optical Convention, 1 Lowther Gardens, 1926.) 6*s.* net.

(1) TWENTY-TWO years ago the first Optical Convention, defined as a conference of opticians "to discuss questions of interest and to promote the general welfare of the Trade," was held in London under the presidency of Sir Richard Glazebrook. It amply fulfilled the expectations of those members of the Optical Society whose prescient minds foresaw the advantages that might accrue to the science and practice of optics.

Seven years later, Prof. Silvanus P. Thompson, the president of the second Convention, held in 1912, in his address to the members declared: "We are met here to exchange views, to deliberate, to discuss, to learn from one another and from the material objects we have been able to bring together in an Optical Exhibition, anything and everything which can stimulate our thoughts, widen our information, or concentrate or harmonise our activities in matters optical."

After a further lapse of fourteen years the third Convention, presided over by Sir Frank Dyson, has recently been held. During that period of fourteen years the optical industry has experienced an extraordinary expansion followed by prolonged post-War depression. But however subdued the present state of the industry may be, there is no apparent abatement of the interest in optics. This is manifested by the two large volumes which embody the proceedings of the Convention. Containing as they do more than ninety papers, some of them miniature treatises, dealing with every aspect, they constitute the largest and most comprehensive addition to the literature of practical and theoretical optics that has ever been made at one time.

Surveying, and particularly that latest development, aerial surveying, forms the subject of fourteen papers. There are ten devoted to visual optics and eleven to photometry. Optical computation takes a prominent place, but only the geometrical aspects of the question have received much attention: practical trigonometrical methods such as are used by the manufacturer still receive little consideration from the mathematicians. For the first time there are included several excellent historical papers.

Since the date of the second Convention the foundations of optics have been overturned and the builders still lack some necessary material for their reconstruction. Only one paper on this basic subject is included. There is also only one paper—fortunately an authoritative one—which deals with that one-time popular instrument, the microscope.

So large a number of papers delivered in so short a time has resulted in a discussion of unduly limited extent; it amounts to about 13 per cent. of the material. In 1905 there was a 22 per cent. discussion, and in 1912, 18 per cent.

The index is scarcely adequate. The illustrations are generally good, but the cover is unattractive. In this respect it would be well in future to depart from the bad example of the 1905 *Proceedings.*

(2) This catalogue is no mere enumeration of the instruments of British origin exhibited at the Optical Convention of 1926. It records the important advancement that has been made by the optical industry since the date of the last Convention; it is a record of advancement that is remarkable when it is realised that all products of purely war character have been excluded. It also

serves as an index to which future progress will be referred.

More than sixty British firms who participated in the exhibition have contributed descriptions of the instruments and optical materials produced or supplied by them. These descriptions are devoid of salesmanship claims and are of special interest, as they express the essentially practical opinions of the manufacturers themselves.

Instruments are well classified under seventeen groups, of which by far the most extensive is that devoted to the microscope, which receives so little attention in the *Proceedings* of the Convention. Ophthalmic apparatus and surveying instruments occupy second and third place respectively. Of the five additional sections, one is devoted to experiment and research, and another to an account of the very valuable collection of historical instruments and books.

The catalogue is well produced, and should be studied by all engaged or interested in the optical industry. J. W. F.

Organic Chemistry.

A Text-Book of Organic Chemistry. By Prof. Dr. Julius Schmidt. English edition by Dr. H. Gordon Rule. Pp. xxiv + 798. (London and Edinburgh: Gurney and Jackson, 1926.) 25s. net.

We learn from the preface that this translation of Schmidt's "Kurzes Lehrbuch der organischen Chemie" arises from the encouraging results that attended the adoption of the German original as a text-book for the advanced students in the University of Edinburgh, and indeed the translator has done his work so admirably and produced so readable a book that there can be no question that it also will find a similar welcome in other English-speaking universities. It is the type of book that the teacher can recommend with confidence to the more ambitious second-year and pass students in organic chemistry, and, in so far as any single text-book can meet the ever-growing requirements of the honours students of a university, this book will prove both helpful and useful.

Following a general introduction of 68 pages, the book treats of the chemistry of the carbon compounds in 687 pages under the three sections (1) the aliphatic or fatty compounds, (2) the carbocyclic compounds, and (3) the heterocyclic compounds. It is obvious that in so limited a space the treatment of so vast a subject could not be wholly adequate, and in this respect the general introduction is perhaps the weakest part of the book; the description of the methods of qualitative and quantitative analysis, for example, is condensed into seven pages and unrelieved by any diagrams. In the three main sections, the chemistry of the hydrocarbons and their derivatives is discussed under their respective headings in the usual order, and one of the most valuable features of the book is the introduction of numerous sub-sections dealing with special groups of compounds—of natural or synthetic origin—as they fall within the category of the compounds under discussion. Some of these are of special interest, as for example those dealing with the polypeptides, with rubber, with the depsides, with the tannins, and with the vegetable alkaloids; the last forms a valuable monograph on the chemistry of these important compounds.

Judging from the numerous references to recent literature, the book has been carefully brought up-to-date, and it is surprising, therefore, to find no reference to the replacement of 'benzine' as a dry cleaning solvent by the chlorinated derivatives for acetylene; no mention of the preparation of synthetic methyl alcohol from water gas; no reference to the now extensive use of thionyl chloride in the preparation of acid chlorides; and no mention of the iodonium bases. In the preface the author states that "although the greater number of references to German literature contained in the original have been retained, some progress has been made towards the inclusion of representative English and American work"; it is therefore to be hoped that when further progress in this direction has been made, many of the unfortunate omissions from the present edition may be rectified, as for example Werner's work on the chemistry of urea, and Armstrong's and Wynne's classical researches on the chloro-derivatives of naphthalene.

Whilst the text is singularly free from errors, the following have been noted: p. 99, line 6 (from bottom), for "arsenite" read "arsinate"; p. 118, line 14, the equation should read $PhONa + (CH_3)_2SO_4 = PhOMe + NaMeSO_4$; p. 122, line 11 (from bottom), for $\beta\beta$ read $\beta\beta'$; p. 131, line 8, for "monobromoacetamide" read "acetbromamide"; p. 199, line 22, the middle formula is faulty; p. 476, line 12, for "boiling" read "melting"; p. 142, the formation of "aldehyde resin" is characteristic of acetaldehyde only. Finally, the reviewer would like to register a mild protest against the printing in formal text-books of laboratory slang terms as "to combust," even if, on its first appearance, the offender be shielded by apologetic inverted commas.

M. A. W.

Our Bookshelf.

Forest, Steppe and Tundra: Studies in Animal Environment. By Maud D. Haviland (Mrs. H. H. Brindley). Pp. viii + 218 + 8 plates. (Cambridge: At the University Press, 1926.) 12*s.* 6*d.* net.

WITHIN the last dozen years the author has seen the tundra and coniferous forests of the Yenisei, the steppes of south-east Russia, and the luxuriant tropical forests of Guiana. From her observations she has put together a picture of animal life in these widely different environments; the different parts of the book are introduced and co-ordinated by a general account of the adaptation of living things to their environment.

The purpose of the book is to show the fauna, as a whole, in relation to the floral and physical environment, and it is interesting to contrast the account of the forest of Guiana with the books of Waterston, Bates, Belt, and the other 'naturalists.' They observed and described: the modern ecologist co-ordinates a greater body of fact, and has been trained in experimental methods, which form a mental background even if experiments cannot be carried out. We suppose that the ecologist of the present day will soon give place to students who use the experimental method more and more. One important result may be expected: nearly every ecologist believes in adaptation; will the next generation of ecologists be able to furnish experimental proofs of it?

With regard to the coloration of animals, the author takes a moderate view. She thinks that belief in protective coloration is often based on a study of colour without study of habit; the sandy lark betrays itself by twittering from the top of a stone. On the other hand, she accepts mimicry as the explanation of the shapes and habits of some membracid bugs of Guiana.

We are becoming familiar with books on ecology written, or so it seems, with a blue pencil, scissors, and a paste pot, the whole cemented to a framework of new terminology. The book under review spares us from that; it is written in plain English, which seems sufficient. We are inclined to criticise the use of English names for a variety of animals from many parts of the world. Only those who pursue zoology that they may solve cross-word puzzles could give an account of the suslik, the Tatar lark, the huanaco, barbet, and bobolink. "Jumping rabbit" is a cruel misnomer for Alactaga, which is near of kin to the jerboa.

The photographs of different types of country are beautiful; there should be more of them.

PATRICK A. BUXTON.

The Theory of Electricity. By Prof. G. H. Livens. Second edition. Pp. vi + 427. (Cambridge: At the University Press, 1926.) 16*s.* net.

THE first edition of Prof. Livens' "Theory of Electricity," published in 1918, was reviewed in NATURE in 1919 (vol. 103, p. 142), and therefore the present notice need only take account of the changes introduced in the new edition. In its present form the book has been very much curtailed—from about 700 large octavo pages to rather more than 400 crown octavo pages—but the clear print characteristic of the series of the Cambridge University Press has been retained. A considerable amount of matter, relating principally to the detailed treatment of a considerable number of special problems, has been omitted in all cases where a full account is given in other books, but we are glad to note that the very careful and full discussions of fundamental principles and points of difficulty, so characteristic of the first edition of the book, have been retained in their entirety. Consequently, the work can be as highly recommended as before as an introduction to the theoretical side of electromagnetism, and in conjunction with such a detailed text-book as that of Jeans, gives as full an account of the theory in all its aspects as is to be found in any language.

In one point Prof. Livens has introduced a decided innovation on the usual treatment. He uses the term *magnetic force* for what is usually termed the *magnetic induction*, **B**, reserving the term *magnetic induction* for the vector **H**, which he regards as the derived vector. The main effect of this innovation appears in Chapter v., on the dynamics of the magnetic field, where the potential energy density of a distribution of magnetic polarisation of intensity **I** is written as $-(\mathbf{IB})$, in place of the usual $-(\mathbf{IH})$. Thus a *negative* potential energy density is obtained instead of the usual positive value; when this is interpreted as *positive* kinetic energy of hidden motions, according to the usual method of Lagrangian dynamics, a result is obtained which is certainly more consonant with theories of the ultimate origin of magnetism than the usual result of the classical theory. To us it seems that the whole question is a very debatable one, and may very well be left to the future for its ultimate decision.

Potash: a Review, Estimate and Forecast. By Dr. J. W. Turrentine. (The Wiley Agricultural Series.) Pp. ix + 188. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1926.) 15*s.* net.

FIFTEEN years ago, America's entire dependence upon imported potash led her to initiate a survey of possible home sources of this essential substance, which was scarcely completed when the breaking out of the War emphasised the importance of developing domestic resources. In pre-War days, Germany practically held the monopoly of the world's potash supply, but afterwards, when France obtained possession of the Alsatian mines, an agreement was made whereby Germany dealt with 62·5 per cent. and France with 37·5 per cent. of American and other demands for potash. In 1922 the world consumption was 1,600,000 tons of potash salts, far below the limit of producing capacity of Germany alone. At present the price is below pre-War rates, and this has caused in America an almost entire deflation of the development of the potash industries which had arisen during the War period. America's need is to push the domestic production of potash to such a point as to secure the possibility of the production of full home supplies in case of war.

Kelp is a valuable asset, as iodine and potash can be obtained as by-products from the manufacture of kelpchar, a very active decolorising carbon. Other sources of supply which can be exploited successfully are surface lakes, subterranean deposits, silicates, industrial wastes (both organic and inorganic), and cement-mill flue dust, the last being a very important potential source. Ninety per cent. of the potash entering American markets goes to agriculture, but the ten per cent. is of equal importance in that it is required for many industries. The feasibility of the recovery of sufficient potash from available home resources has been demonstrated, and the immediate problem is that of perfecting the methods employed and rendering the recovery process an economic proposition.

Mono-Alu Folklore (Bougainville Strait, Western Solomon Islands). By G. C. Wheeler. Thesis approved for the Degree of Doctor of Science (Economics) in the University of London. Pp. xv + 396. (London: George Routledge and Sons, Ltd., 1926.) 21*s.* net.

This collection of tales and song-texts given in this volume was made during a stay of ten months in Alu and Mono, Bougainville Strait, in 1908–9. The author has given the texts as taken down from the dictation of a Mono-Alu man, son of a late chief, and the Mono text is given in all but eight cases. Although traces of the old Alu speech are to be found in the tales, that language has practically disappeared and Mono has taken its place, owing to the conquest of Alu by the Mono people some sixty years ago. In these islands, therefore, Mono-Alu-Faura now form a unit area. The tales as presented by Dr. Wheeler provide much valuable material for linguistic study, but more important in some respects is the light they throw on the culture of the people. The tales, indeed, enshrine much that has already passed away. Dr. Wheeler himself points out, for example, that the incident of wrapping blood in a leaf which occurs in one of the most interesting and bizarre of the stories, in the actual practice is a feature of a rite analogous to the motive. In another story bones renew their life, a motive which stands in relation to the burning rites for a dead body in the Mono area. Similar analogies and references could be quoted time after time. Dr. Wheeler's scholarly volume will well repay careful study.

The Aspergilli. By Charles Thom and Margaret B. Church. Photomicrographs by G. L. Keenan. Pp. ix + 272 + 4 plates. (Baltimore, Md.: Williams and Wilkins Co.; London: Baillière, Tindall and Cox, 1926.) 22*s.* 6*d.* net.

While this work is primarily and confessedly taxonomic, the authors have brought together most of the scattered information on the Aspergilli, and have given a comprehensive survey of the genus from a few different points of view. Part I. deals with such different aspects as culture methods, morphology, and special physiology of these forms. A very interesting chapter is devoted to enzymatic activities, and their economic significance in the production of acids, *sake*, taka diastase, etc., while their pathogenic importance in reference to man, birds, and insects is treated in another.

Part 2 of the book is devoted to a taxonomic revision of the whole genus based on the examination of large numbers of forms from natural substrates, and the 350 strains which the authors have grown in pure cultures in their own laboratory. While the sixty-six odd accepted species of Aspergilli have been considerably multiplied, an attempt has been made by the authors to indicate real relationships in the presentation of their various groups, and the diagnostic scheme in their keys has been so arranged as to bring together closely allied forms. A fairly exhaustive bibliography is appended to the work, which forms a welcome addition to current mycological literature.

Maori Symbolism: being an Account of the Origin, Migration, and Culture of the New Zealand Maori, as recorded in certain Sacred Legends. Report made by Ettie A. Rout, from the evidence of Hohepa Te Rake (an Arawa Noble). Pp. xxxii + 322 + 32 plates. (London: Kegan Paul and Co., Ltd., 1926.) 21*s.* net.

In this book Mrs. Rout reports the sacred lore of the Maori as faithfully transmitted to her by a Maori noble, Hohepa Te Rake, and solemn declarations to that effect by both participants in the production form part of the contents. It is, however, difficult to accept these statements at their face value, as the lore is not given in its original form, but as interpreted in the light of a theory of the origin and migrations of the Maori, based upon identifications which trace them back to Assyria and suggest identity of culture in Egypt, America, and elsewhere. The illustrations, which are exceptionally well reproduced and in another context would be both interesting and suggestive, have been carefully selected with this end in view. In spite of this defect the book does, however, contain a very full account of the customs and practices of the Maori which conduced to sound sanitation, personal cleanliness, and good health.

Practical Colloid Chemistry. By Prof. Wolfgang Ostwald, with the Collaboration of Dr. P. Wolski and Dr. A. Kuhn. Translated by Dr. I. Newton Kugelmass and Dr. Theodore K. Cleveland. Pp. xvi + 191. (London: Methuen and Co., Ltd., 1926.) 7*s.* 6*d.* net.

This laboratory manual has been well known to workers in colloid chemistry since the first German edition appeared in 1920, and in the variety and completeness of the course provided it reflects the versatility and enthusiasm of the chief author. He has, however, been badly served by his translators, whose frequent misrepresentations need to be seen to be believed, and to be compared with the German to be understood. P. C. L. T.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Band Spectrum of Mercury from the Excited Vapour.

I WISH to bring forward one or two additional results on this subject in supplement to my letter published in NATURE of Nov. 27, 1926.

In the first place, I found that the green visual band, extinguished by heat, recovers to some extent as the excited vapour moves on to a cold part of the tube. This effect has been satisfactorily photographed.

As emphasised in published papers, the main part of the band spectrum covers the whole region on the less refrangible side of the resonance line λ2537, at which point it abruptly begins.

I now find that the 'forbidden' line λ2270 is present on the plate, and that a separate stretch of band spectrum reaches from this point to the band λ2345. In the region of wave-length less than λ2270, and also in the region between λ2345 and λ2537, the background of the spectrum is quite dark.

Prof. Takamine has suspected that the band λ2345 was associated in some way with the 'forbidden' line, and he suggested to me some time ago to look for this line in the excited vapour. It was not to be seen on the negative then available. My present negative has been made with an improved technique, and exposed for as much as 100 hours. I do not think it has been suspected before that a stretch of continuous spectrum begins at λ2270, and connects up with λ2345 and the associated bands of intermediate wave-length.

RAYLEIGH.

Terling Place,
Chelmsford, Essex, Mar. 1.

Some Comments on Current Science.

THE COURSE OF COSMIC EVOLUTION.

MANY, like myself, will be interested in Dr. Jeans's letter in NATURE of Feb. 26, p. 315, and will wish to congratulate him on the confirmation, or rather the realisation, of his calculated states. The question will be asked, however, whether he is led to think that the universe ever was in that uniformly distributed initial state, or whether its proved instability is an argument that that condition never actually occurred. One view of evolution is that the general appearance of things on the whole was not very different from what it is now, and that the various processes have gone on concurrently in different regions. I am wondering, and I expect others will be, whether it is his view that the universe evolved, so to speak, as a whole, with an initial state entirely different from its present state. In a gas of density 10^{-31} I reckon the molecules about 5 metres apart on the average—a curious state of things, of philosophical importance, if it ever really happened. There can scarcely have been a beginning for time! Though I suppose that, as there is a beginning for a solar system, there may have been a beginning for the universe as a 100-inch telescope sees it. But it is not an easy idea: or rather perhaps it is too easy to be satisfying; unless the universe is really infinite, when even the scope of the 100-inch would be but a unit.

THE DOWSING OR DIVINING ROD.

I have not myself studied the particular activity of the subconscious mind that is apparently operative in the detection of things hidden from the normal senses, but I have discussed it from time to time with the late Sir William Barrett, and I feel justified in saying that he would have appreciated and welcomed the review by Dr. H. R. Mill in NATURE of Feb. 26, p. 310. That we have as yet no satisfactory explanation of the phenomenon is true enough; but then that is equally true of many other obscure human and animal faculties, which react to the environment in a surprising manner. My own view is that we shall not begin to understand these things so long as we attend to our material environment alone. There is an etherial environment too; and it may be that that is the home of the subconscious, in the same sense as matter is the home of the conscious part of our minds. Probably everything psychic has a physical concomitant, which can some day be tracked down; but the adjective 'physical' is not limited to matter, else light and electric waves would be excluded. Already our instruments respond to non-material though truly physical disturbances; and it may be that some unrecognised parts of our bodily mechanism, or unconscious brain centres, are capable of response too.

I am myself inclined to think that we shall find ourselves more directly or immediately concerned or connected with the ether than we are with matter, in spite of the fact that matter looms so large to our familiar senses. We can only gradually confirm or negative a guess of that kind by following such clues as are available. I heartily re-echo the concluding words of the review, to the effect that those who only attend to the subject with a determination to prove that the whole thing is humbug will discover nothing.

PATHOLOGY OF LAMP FILAMENTS.

It sometimes happens that the facts of one science can be suggestive of ideas and possible fruitful inquiry in another quite different science, provided the devotees of that other science are made acquainted with the relevant or suggestive facts; but admittedly the disciples of the first branch of knowledge must be cautious how they obtrude, lest they seem presumptuous and interfering in matters beyond their ken. In the heading of this letter I venture to use the non-physical term 'pathology' in order to direct the attention of real pathologists to a recently observed and explained trouble encountered by manufacturers of electric lamps and vacuum valves, the filaments of which are sometimes subject to what may be called an inorganic, non-microbic, and purely chemico-physical disease.

At a recent meeting of the Royal Society of Arts on Feb. 16, an interesting paper, accompanied by experimental demonstrations, was read by Mr. C. C. Paterson, director of the Research Laboratories of the General Electric Company at Wembley: and from this paper I want to make a few extracts in order to attract wider attention to some of the results obtained by the brilliant staff at work there under exceptionally favourable conditions. The thorough knowledge necessary before trustworthy pieces of apparatus can be manufactured and turned out by the million is obvious, and the experience gained in the organisation of such mass-production is often of scientific importance. Here, then, is one of the side-issues of lamp and valve manufacture.

It is found that in gas-filled lamps, the filaments of which are made of tungsten, it is essential to reduce the residue of water vapour down to the lowest minimum possible; for water vapour has, on the coiled filaments of such lamps, a specific and recognised action that gradually and sometimes rapidly weakens and destroys the ignited filament, by thinning it down at one place and thickening it in another; the action, once begun, tending to go on more and more rapidly, since the thinner part gets automatically more heated and the thicker part more cooled. The action is described by Mr. Paterson as follows:

"Molecules of water vapour left in the bulb are decomposed into hydrogen and oxygen in contact with the hot parts of the filament. The oxygen immediately combines with some of the tungsten atoms at the hottest spots with the formation of tungsten oxide. This tungsten oxide is deposited on to a neighbouring cooler part of the filament where reduction of oxide can take place, [since] the cast-off hydrogen atoms can again claim their oxygen from the tungsten oxide. The tungsten atoms thus left coalesce with the filament at its cool point, with consequent thickening of the filament. Meanwhile the molecule of water vapour, now re-formed, is free to attack again the hotter part of the filament. This point becomes continuously hotter by virtue of its diminishing diameter. Thus the molecules of water vapour act much as ants, carrying particles of tungsten from one place and building them up in another, and become available over and over again as the carriers of tungsten atoms. Hence the potency of water vapour as a destructive agent. The quantity must be reduced to vanishing proportions if it is not to cause wastage and growth in this way during the long high-temperature life of a gas-filled lamp."

That water should act as a catalytic poison, in this way, is rather in accordance with the pronouncements of Prof. H. E. Armstrong about the influence of water and of traces of impurity in chemical reactions generally; for under other conditions traces of other substances may be acting in a similarly unstable or top-heavy way. In fact, Mr. Paterson elsewhere says that "in gas-filled lamps, and before gas-filling takes place, every possible trace must be removed of water vapour, because this acts in relation to the gas-filled lamp filament as cancer does in the animal body, and causes alternate local growths and wastage." He further points out that at the high temperature of a lamp "chemical reactions are extraordinarily vigorous, and many of them unexpected—water vapour is not the only vapour or gas which must be guarded against."

Whether there is likely to be any impurity in the blood or tissues that under vital conditions might act in a catalytic manner and build up local growths at the expense of tissue elsewhere, even in the absence of any microbe or customary disease agent, it is for biologists to decide. The idea may have occurred to them; but an actual instance occurring in the physical laboratory may cause them to pursue the idea further. I will only say this: The activity of an electrolyte capable of dissociation in a liquid—as in many saline solutions—is known not to be very different from the activity of the free molecules of a gas.

OLIVER LODGE.

Normanton House,
Lake, Salisbury.

Hereditary Choice of Food-plants in the Lepidoptera and its Evolutionary Significance.

THE problem of the practical differentiation of species in Nature stands so much in need of experimental work, that the recently published paper by Dr. J. W. Heslop Harrison on an apparently successful attempt to influence the hereditary instincts of a sawfly (*Proc. Roy. Soc.*, Series B, vol. 101, pp. 115-126) will be read with interest, and I am induced to offer one or two critical remarks.

This sawfly, *Pontania salicis*, is stated to feed on many species of Salix, but in any given locality to restrict itself habitually to some one (not the same) species, although several others may be equally plentiful. I do not dispute the statement, but in the whole of the Lepidoptera I have never heard of a similar instance. Salix, in particular, supports a large number of Lepidoptera, but in general the only discrimination made is between the rough- and smooth-leaved species (probably influenced by touch rather than taste), and, again the choice of *S. repens* by certain species seems due rather to the superior shelter afforded by the dwarf habit. Also the Pontania is a gall-maker; and the case of gall-producers, where complicated reactions ensue between insect and plant, may be specially difficult to understand. In the experiments the change was produced immediately, and was completely established in three years; there must be some quite unusual element here.

From this single and quite exceptional case, however, Dr. Harrison proceeds to deduce what he calls a new principle of evolution, which I understand to be that in phytophagous insects (for example) pairs of allied species are produced by the accidental transference of larvæ from the usual food-plant to an adjacent allied plant, or even to one usually associated with it but not allied. Several pairs of species of Lepidoptera are instanced as suitably associated "in Britain," as, for example, *Cerura bicuspis* and *C. furcula*, but this argument is wholly fallacious, involving the assumption that one of the species originated here; both range over the whole of northern and central Europe and Asia, and the circumstances of their origin are entirely problematical. But is there anything new in the principle? All lepidopterists are aware that not merely pairs, but also whole groups of species, tend strongly to feed on allied and associated plants, and this would appear to be probable on any theory of the mechanism of evolution; and microlepidopterists in particular have long ago suggested that the closely similar species in such genera as Phthorimæa and Lithocolletis, each attached to its own food-plant, originated as phytophagic races.

The trouble is that no one has yet evolved a new species by this means; and I shall be very much surprised if, when this is accomplished, it proves to require only three generations of the insect. But even this achievement will not go very far to explain the formation of species in the Lepidoptera. A very large proportion of these (such as most of the very common British Caradrinidæ) have larvæ which feed either on grasses generally or on miscellaneous low plants almost indiscriminately, and without any variation resulting except perhaps of size; and a further large class feed on dead wood and dry vegetable refuse. The same influences which have resulted in the multiplication of species in these groups must be supposed equally efficient in the groups which are more specialised in their tastes; and, subtracting their effect, not much will remain for that of the food-plant. I have even recorded ("Exotic Microlepidoptera," vol. 2, p. 521) the case of two Indian species of Bactra, separable with difficulty, known only from series reared together from larvæ feeding on the same individual plants in the same way at the same time.

EDWARD MEYRICK.

Thornhanger, Marlborough,
Feb. 19.

Rotation of Bodies with Dielectric Surfaces in Electrostatic Fields.

Referring to Dr. S. W. Richardson's letter in Nature of Feb. 12 on the rotation of dielectric bodies in electrostatic fields shown by Mr. L. G. Vedy and Mr. G. Gowlland, at the recent exhibition of the Physical Society, it may be of interest to point out that at the Exhibition in 1896 I showed two experiments which seem to bear on the subject. The first was with a *highly dried* dielectric liquid. If a spherical electrode is fixed some 5 mm. or 6 mm. above the surface and charged from one pole of a Wimshurst, the other pole being earthed, the liquid quietly rises up in a conical form, attaches itself to the electrode, and remains suspended while the field is maintained.

If this same liquid is then exposed to the atmosphere or otherwise absorbs a small percentage of moisture, on repeating the experiment—while there is still a tendency to lift the liquid—there is an even stronger one to depress it in places resulting in great turbulence, hollows, and sometimes whirling motions, all of which vanish if the liquid is again dried.

In a letter in Nature for April 5, 1924, I showed that the properties called 'absorption' in dielectrics at ordinary frequencies are also due to small percentages of moisture and can be greatly altered by varying this. It would, therefore, appear that with dielectric liquids these effects are also due to 'absorption'.

If a short bar of a good dielectric, but showing some absorption, is placed between two electrodes, but with air-gaps, and a fairly strong field is maintained in a dried atmosphere for some time and it is then, with insulating tongs, brought near an electroscope, the two ends show opposite charges, and these take time to die out. This action is separate from the opposite induced polarity of the mass of the molecules of the dielectric, which is instantaneous, and disappears instantaneously when the field is removed. This latter action appears to take no part in the rotations which are due to interaction between the field and moisture in the dielectric, or to its 'absorption'.

In the letter referred to I mentioned that to produce the absorptive effects it was not enough to assume the dielectric constant of water as 80, but that the only conclusion was that when small percentages of moisture are occluded in dielectrics, much, at any rate, must exist in an ionised form, when the reaction of the separated ions with an outside field would be much more powerful.

From observation of the experiments I gathered that rotation only occurs when brush discharges of sufficient magnitude pass between the electrodes and the rotating body.

If a sheet of a good dielectric is held near such a charged electrode, and is then brought to an electroscope, the surface of the dielectric shows a charge, but it is *of the same polarity* as the electrode producing it, instead of having the opposite induced polarity which it would have had if the dielectric had been held at a greater distance.

Now when a dielectric having in it ionised moisture is placed in an electrical field, the negative ions are strongly attracted towards the positive electrode, and vice versa, and these ions tend to be drawn through the dielectric and to accumulate under the opposite surfaces. Primarily this would produce opposite induced polarity; but if the field is sufficiently strong there is evidence that some of the opposite ions are actually pulled out of the dielectric and drawn to the electrode. This leaves the dielectric opposite the electrode with a free charge, *but of the same sign* as the electrode, causing strong repulsion.

To start the rotations there must be initial movement of the dielectric or some want of symmetry. The rotation takes place either clockwise, or counterclockwise, depending on the direction of the initial impulse.

Thus if a block of dielectric is placed in a strong field the electrodes extract opposite ions from the two opposed surfaces and leave each with a strong charge of the same sign as the opposite electrode. When the dielectric is given a slight movement one way or the other, these charges are repelled by the electrodes and both unite in turning the dielectric in the same direction. Now these charges in the dielectric, if the dielectric is what is called 'good,' or has a sufficiently high resistance, take some time to die away. They are continually renewed as fresh surfaces of the dielectric pass the electrodes, and, on the other hand, as the rotation carries each charge round towards the next electrode the charge will be of opposite sign and therefore will be attracted until it gets under the electrode. As it comes under the second electrode the attraction will draw the ions of opposite polarity out of the dielectric and again leave it with a charge of the same sign, again producing repulsion, all the actions thus uniting to produce motion in the same direction.

Surface moisture will also give rise to the same actions if the film is sufficiently thin. If, however, the film forms a layer of low enough resistance, surface conduction will neutralise the opposite charges on the dielectric and thus reduce or stop the rotation. This was observable in some of the experiments. For example, a metal cylinder wrapped with paper would not rotate until the paper was dried, and the same inability to rotate occurred with a glass beaker before it was surface dried.

Speaking generally, this seems to be the explanation of these interesting demonstrations.

I have been investigating actions of this character during the last two years under conditions calculated to show their causes more clearly; the results, it is hoped, will be published shortly.

G. L. Addenbrooke.

35 Holland Villas Road,
Kensington, W., Feb. 21.

The Effect of Intense Light on the Energy Levels of Atoms.

In 1923, Bohr (*Z. f. Phys.*, 13, p. 117; 1923) directed attention to the fact that the usual formulæ of the older quantum theory might not be strictly applicable to atoms which are subjected to intense radiation fields of high frequency, such as those of ordinary light. Schrödinger (see particularly equation 16, *Ann. d. Phys.*, 81, p. 109; 1926) has formulated the differential equation for the ψ-function of an atom exposed to a harmonic electric force, and from this the allowed values of the quantity E appearing in the equation may be determined. In such a case, however, the physical interpretation of E is doubtful, though it seems highly probable that it represents the (average) energy of the disturbed atom. Thus we cannot be certain that the equation $E_1E_2 = h\nu$ is correct for calculating the frequencies emitted by such an atom. Whatever be the final formulation of the theory, it seems reasonable to suppose that the energy levels of atoms in sources at very high temperatures may be modified by the electric and magnetic fields of the radiation from the source itself.

Mr. W. Kuhn (*Z. f. Phys.*, 38, p. 440; 1926) devised an interesting experiment for detecting changes in the energy levels of sodium atoms illuminated with wave-lengths near the D lines, and performed it in collaboration with Mr. R. de L. Kronig. By analogy with the classical theory of dispersion, such wave-lengths should be capable of producing disturbances quite large compared with those produced by wave-lengths much farther from the resonance lines. Briefly, the experiment consisted in studying the D line absorption of sodium vapour illuminated by a suitable continuous background, (1) when it was also illuminated by the broadly reversed D lines from a very intense sodium source, and (2) without this intense illumination. The temperature of the absorption vessel was so regulated that wave-lengths extending about 0·03 Å.U. on either side of the centre of a D line were absorbed and the temperature of the intense source was such that the reversal was about 0·06 Å.U. wide. The effective radiations lay mainly at a distance between 0·03 and 0·06 Å.U. from the centres of the D lines, so that the total range of wave-lengths utilised in the neighbourhood of either D line was about 0·06 Å.U. Kuhn states that an approximate computation indicates the possibility of a shift of 0·15 Å.U. for the D lines in absorption, due to the alteration of the energy levels of the sodium atom. He gives no details of his calculations. Therefore no statement can be made here as to the way in which the phase differences of the monochromatic constituents of the incident light were taken into account. But leaving aside all theoretical questions, the experimental result was that no such broadening or shift could be detected.

It is the purpose of this note to point out that if such an effect exists, it should be readily possible to detect it in the solar spectrum, or better, in the spectra of very hot stars. To show this we note that the intensity of the yellow sodium light used by Kuhn corresponds to an energy density in the light beam of $400 \times 900/c$ ergs per c.c. For an atom at the surface of the sun we may suppose as a rough approximation that the effective energy density corresponds to about five-sixths of the energy density of isotropic black body radiation. That is, if we consider a unit cube in which the atom is placed, we see that black body radiation of the temperature appropriate to the sun streams in through five sides of this cube, since about one-half of the total solid angle is subtended by the sun at this position. Calculating from Planck's formula, the energy density of black body radiation carried in a wave-length interval of 0·06 Å.U. units at the position of the D lines, we find the value $3{\cdot}4 \times 10^4/c$ ergs per c.c. This must be doubled to take account of radiations in the neighbourhood of both D lines. The result, $6{\cdot}8 \times 10^4/c$ ergs per c.c., is twenty times as large as the figure given by Kuhn.

Kuhn's calculation of the change in energy levels depended upon the assumption that the atoms are subjected to an electric force E obtained from the equation

$$\text{Energy density} = E^2/4\pi.$$

This is open to considerable question. In calculating the actual electric force acting upon an atom, it may be necessary to take the microscopic structure of the wave front into account. Looking at the question from the point of view of the theory of uni-directional quanta (simply for the sake of convenience), it seems reasonable to suppose that many of the absorbing atoms may not be affected at the moment of absorption by any quantum belonging to the intense beam. This objection may also be applied to speculations on the possibility that atoms are oriented by the electric and magnetic fields of incident radiation, an idea which is sometimes invoked to explain the polarisation of resonance radiation in cases which do not yield to the usual theories. Arguments based on analogy with Huyghens' principle in classical optics could no doubt be given to show that the detailed structure of the wave fronts may be neglected; but the attitude adopted here consists essentially in questioning the validity of such evidence.

Further, it should be remembered that in Kuhn's experiment (uni-directional illumination) only half the energy density is effective in producing a polarisation of the atoms parallel to a given direction in a plane normal to the beam. A similar factor must be applied for atoms in celestial sources, but since we are interested only in the order of magnitude of the effects, we shall not discuss the matter further.

It may be that an effect of this kind exerts a detectable influence on wave-lengths in celestial sources. Whatever the verdict may be, the question can only be settled by those familiar with the complexities of astrophysical spectroscopy. Such an effect cannot be easily disentangled from those due to other physical disturbances. The question should certainly be considered in future discussions of the Einstein red shift and of peculiar motions in the line of sight.

Arthur E. Ruark.

Yale University,
New Haven, Conn., U.S.A., Jan. 24.

The Behaviour of Polyploids.

Mr. Huskins' description (Nature, Jan. 8, p. 49) of the strict correlation he has observed between abnormal chromosome behaviour and abnormal breeding results in fatuoid oats encourages me to put forward suggestions based partly on analogous observations of my own.

The basic chromosome number throughout the genus Prunus appears to be 8. *P. cerasus*, *P. acida*, and *P. fruticosa* are tetraploid relatives of the diploid *P. avium*; *P. domestica* and *P. insititia* hexaploid relatives of the tetraploid *P. spinosa* and the diploid *P. cerasifera* and *P. triflora*. In both the sour cherries and the plums I have found in particular individuals at one reduction division complete pairing, at another the formation of a trivalent and a univalent instead of two of the pairs, or of two trivalents and two univalents instead of four pairs. This occurrence in an orthoploid is analogous with what Mr. Huskins has observed. Furthermore, in these cherries secondary association of bivalents may occur, and in some cases the chromosomes are associated in eight groups of four. The segregation of the parts of these quadrivalents must be, from their form, if not haphazard, at least not predetermined.

There is, however, a further significance in this variable pairing which is perhaps better shown by another example. In 1914 Mr. Crane, at Merton, crossed *P. cerasifera* on *P. domestica*; the single seedling resulting from 750 indoor pollinations has now been examined. Behaviour at the reduction division is not distinguishable from that in tetraploids such as the sour cherries, and irregularity is of the same degree. We have thus shown, what has not yet been proved in the hexaploid cereals, that the three sets of the gametophyte complement of the plum are all homologous with one another, or with the one set of a related diploid species.

If, on hybridisation, chromosomes of any one set in the plum are capable of pairing with their respective homologues of any of the other five sets, we must not assume that this freedom is effective within the species itself, yet it is possible that choice of mate is less restricted than in a simple diploid. The importance of this is indicated by a calculation of the number of chromosome-types in the offspring that may be produced by selfing a diploid with 48 chromosomes, in which every one of the chromosomes is distinct from its homologue, and a similar individual in which complete freedom of pairing prevails—a functional hexaploid. In the first case the number is $1{\cdot}4 \times 10^{14}$ and in the second $3{\cdot}6 \times 10^{\text{[illegible]}}$; this disproportionate increase no more than corresponds with the unparalleled diversity which Crane (1921) has actually discovered in the selfed offspring of certain plums.

This analysis of a polyploid brings us, I think, to the same conclusion as the synthetic method that has been successful in Nicotiana, *Primula kewensis*, and the Brassica-Raphanus cross and accidentally, as it were, in *Primula sinensis* and Fuchsia—the conclusion that polyploids have often arisen as the immediate or eventual result of hybridisation between diploid species and that, although the varying affinities between their parents are reproduced in the varying affinities between their constituent chromosome sets, their constitution is hybrid in all those respects in which their diploid parents differed. It is noteworthy in this respect to recall that the most successful experiments in the study of hybrid vigour have been carried out with diploids.

Now so long as a polyploid pure line is selfed its intrinsic hybridism remains latent, but on crossing with a related species possibilities of *secondary segregation* must be considered. Supposing, for example, speaking crudely for the sake of brevity, we imagine the tetraploid species *Triticum durum* made up of two species A and B and *T. polonicum* of two others C and D, how will pairing take place in an F_1 between these two? It has been assumed always that pairing is only possible between A and B chromosomes on one hand and those of C and D on the other. My observations and the whole probability with regard to the relations of the original species incline me to conjecture that, while this may be true of most of the members of each set, others are likely to be less fixed in their association, and others again possibly pair A with B and C with D. Characters in which the parents differed, determined in these last chromosomes, would then never be fully recovered from the progeny of the cross. Further, new characters would be discovered sometimes even exaggerating the peculiarities of one parent, and expected new combinations would fail to occur. These phenomena are exactly what Backhouse (1917) observed, ascribing them to "zygotic inhibition," and Engledow (1920) ascribing them to "shift"; although it has always been clear that these were not the inevitable concomitants of interspecific hybridisation (Belling, 1915). Gates (1915) has described a similar occurrence in forms not polyploid but possibly aneuploid, ascribing it tentatively to "gametic contamination," but offering the still adequate alternative of a cytoplasmic influence.

I venture to conclude, therefore:

1. That the possibilities of segregation in a functional polyploid are enormously enhanced as compared with those in a comparable diploid.
2. That a pure line of a polyploid species may retain the heterosis of an interspecific F_1 when selfed.
3. That crossing such a line with a related species exposes the latent heterosis, causing
    (*a*) Appearance of new and extreme forms (Backhouse);
    (*b*) Failure to recover the parental form (Engledow and Vavilov).

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London, S.W.19, Jan. 12.

Prothetely in Insects.

IN the hemimetabolic insects, the nymphs at a very early stage of development possess rudiments of almost all the organs of the adult, for example, wings, compound eyes, etc., whereas in the holometabolic forms the appearance of these organs is postponed to a definite later stage, namely, the pupal instar. Numerous cases, however, are on record in which the larvæ of the holometabolic insects also showed wing pads, etc. The first communication on this subject was made so long ago as 1813 by Majoli, who observed that certain silkworms after the fourth moult developed directly into moths without spinning a cocoon or passing through a pupal stage. It was in 1896, however, that Heymons definitely described the phenomenon in mealworms (*Tenebrio molitor*). Kolbe in 1903 reviewed all the cases known at that date, and concluded that the appearance of these organs is premature and is due to accelerated development; he therefore gave the name 'prothetelie,' or prothetely, to the phenomenon. Since 1903 numerous cases of prothetely have been reported, and thus the phenomenon is now recognised to be of fairly common occurrence amongst insects, especially in the orders Coleoptera and Lepidoptera.

In view of the important bearing of prothetely on the metamorphosis, phylogeny and evolution of the higher orders of insects, numerous theories have been propounded, all based on the assumption of Kolbe that the phenomenon was a case of accelerated development. Unfortunately, nobody tried to verify the assumption by experiment or otherwise.

In 1924, while breeding *Tenebrio molitor*, the species which had afforded the classic example of prothetely, I observed in a culture which was being kept at about 28° C. that although most of the larvæ pupated normally, some remained, which, as time progressed, grew more and more inert, ceased active feeding, and began to show wing-pads and other characters usually associated with prothetely. The larvæ thus affected, if they moulted at all, did so with great difficulty. Only a few of them ultimately pupated, but the pupæ were abnormal in appearance. The affected larvæ, when put in a lower temperature, became active and lively.

These observations suggested that the prothetelic changes in mealworms were not obviously the result of the accelerated development on account of which the phenomenon is designated prothetely, but rather of inhibited metamorphosis.

This hypothesis was investigated by means of a long series of experiments, which conclusively showed that wing pads and several other imaginal organs, including the proliferation of testes, appeared in those larvæ only which were kept at a temperature too high or too low, and consequently could not pupate, although controls of the same brood kept at optimum temperature had in the meantime pupated. Thus under the influence of unsuitable temperature the metamorphosis of the individuals had been inhibited and, in spite of this, there had been a tendency for their imaginal organs to appear at the proper time.

These experiments were reported in the *Jour. Camb. Phil. Soc.*, 1924, when it was also shown that in almost all the previously recorded cases where details were known, the pupal organs had most probably appeared only in those individuals whose larval life had been excessively prolonged. In view of this the writer suggested that all the cases of prothetely were really 'neoteny,' and that the name 'prothetely' for the phenomenon was not only superfluous but also misleading.

These conclusions, diametrically opposed to those hitherto held, naturally required confirmation. This has come from quite an independent source. Recently (*Jour. Exp. Zool.*, 1926) Chapman, apparently unaware of my work (he does not make any reference to it), has studied the phenomenon in *Tribolium confusum* Duval, and has also come to the conclusion that wing-pads, etc., appear in those larvæ alone whose metamorphosis has been inhibited. It is interesting to point out that in his experiments the inhibiting factor was not unsuitable temperature, but a peculiar gas given out by the beetles.

There is therefore no doubt that the name 'prothetely' for this phenomenon should be dropped, and along with it should go the numerous theories based on the assumption that the phenomenon is a case of accelerated development.

Incidentally, the above facts raise several questions as to the origin and mode of metamorphosis. A discussion of those must be reserved for a future communication.

Hem Singh Pruthi.

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Zoological Survey of India,
Calcutta, Jan. 20.

The Occurrence of Branched Lint Hairs in Egyptian Cotton.

During the past three months I have been engaged on measurements of ribbon width of cotton hairs for the determination of 'fineness' as described by Harland (*Journal of the Textile Institute*, vol. 15, No. 1; 1924). In one sample of Sakellaridis of good quality a branched hair was noticed and photographed. Fig. 1 shows the hair as originally observed in a small bunch of some thousand hairs. In this instance the camera was focussed on to the lumen of the hair and distinctly shows the fibrillar structure on the inner surface of the secondary thickening as described by Balls (*Proc. Roy. Soc.*, B, vol. 93; 1922).

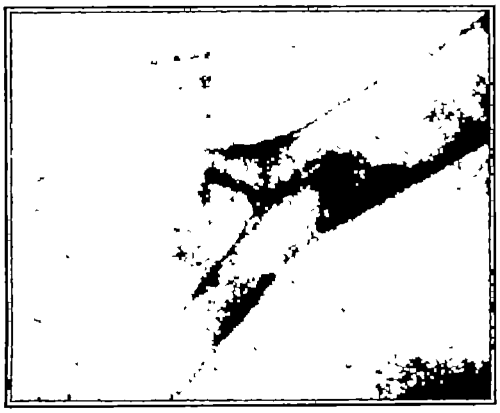

Fig. 1. (×700.)

The small lateral branch was difficult to focus owing to its being crossed by other hairs which show as dark shadows in the photograph. An attempt was then made to disentangle this branched hair and remount it so as to obtain a better view of the lateral branch. This trying operation was successfully accomplished, but not without mutilation, and a photograph taken (Fig. 2).

Further examination of this sample of cotton has revealed the existence of what might be more correctly described as lateral protuberances rather than branches. One of these is shown in Fig. 3. Investigations are being continued to ascertain the extent of the occurrence of this structure and its probable influence on the spinning properties of the cotton.

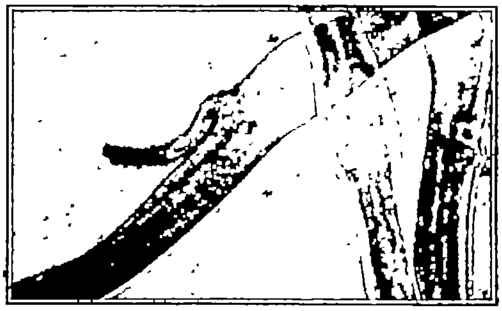

Fig. 2. (×500.)

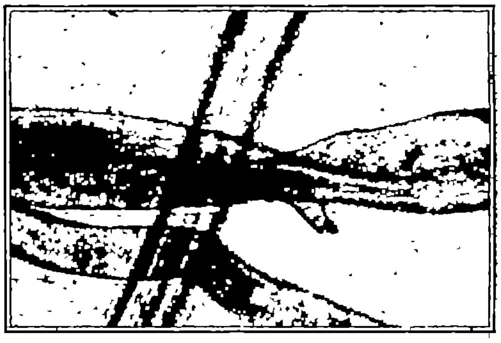

Fig. 3. (×500.)

N. W. Barritt.

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Jan. 18.

The Formation of Twin Metallic Crystals.

The reply of Messrs. Carpenter and Tamura appended to my remarks (Nature, 119, 120-121, Jan. 22) on their description of twin boundaries in metal crystals makes it clear how what I must continue to view as their misconception of the problem has arisen.

They fix attention upon an arbitrary unit of structure—in the case most discussed, a face-centred cube—and do not consider as a permissible twinning plane any plane which does not pass through the centre of this unit. This amounts to ascribing *physical significance* to the position in space of a set of lines and planes which are merely *mathematical conveniences*.

A better way of proceeding is to consider the whole array of atom-centres on one side of a twinning plane as derivable from the corresponding array on the other side by reflection therein, or by rotation about a suitable line. If, however, a unit of structure bisected by the twinning plane is desired, it can easily be found. In the case of the face-centred cubic arrangement such a unit of structure is—if my description is the correct one—a cube with atom-centres at $(0, 0, a/2)$, $(0, a/2, 0)$, $(a/2, 0, 0)$, $(a/2, a/2, a/2)$ and at points derived from the first three of these by translations of amount a parallel to the cubic axes. Atom-centres therefore lie at the centre of this cube and at the mid-points of its twelve edges.

Contrary to the most recent statement of Messrs. Carpenter and Tamura, reflection in an octahedral—[111]—plane through atom-centres involves in the diamond structure the same abnormally small distance between atom-centres—two-thirds the normal distance—as does reflection in the octahedral plane they first considered.

In this connexion it is interesting to observe that in the diamond-like structure of silicon it is possible to choose a position for an octahedral twinning plane which involves no change in least inter-atomic distance. Such planes cut orthogonally the cube-diagonal *in the usually chosen unit of structure* at points distant $a\sqrt{3}/8$, $11a\sqrt{3}/24$, $19a\sqrt{3}/24$ from a corner of the cube. One cube which is bisected by such a twinning plane has atom-centres at the points

$$\begin{cases} (a/8,\ a/8,\ a/8), & (a/8,\ 5a/8,\ 5a/8), & (3a/8,\ 3a/8,\ 7a/8), \\ (3a/8,\ 7a/8,\ 3a/8), & (5a/8,\ a/8,\ 5a/8), & (5a/8,\ 5a/8,\ a/8), \\ (7a/8,\ 3a/8,\ 3a/8), & (7a/8,\ 7a/8,\ 7a/8). & \end{cases}$$

In this case the twinning plane passes through no atom-centres.

No general rule can be stated as to whether the twinning plane for least lattice distortion contains atom-centres or not, since, as seen above, this depends upon the lattice.

L. W. MCKEEHAN.

Bell Telephone Laboratories, Inc.,
New York, N.Y., Feb. 4.

The Origin of Humic Matter.

THE origin of the humic matter of coal, peat, and the soil has been the subject of controversy for many years. At present an increasing amount of support is being given to the hypothesis of Fischer and Schrader, who regard lignins as the parent substances of humic matter. The older view, according to which carbohydrates (notably cellulose) are primarily concerned in the production of humic matter, finds less support than formerly. Waksman has suggested that the humic matter of soils is a mixture of unchanged lignins with the organic substances derived from the life processes of micro-organisms.

For some time past this question has been under investigation in the chemical department of this Station. On the whole, the results so far obtained are in favour of the origin of humic matter from lignins. There is a marked resemblance between the general properties of lignins and humic acids. We are now studying the action of aqueous sulphur dioxide under pressure on a variety of humic acids prepared from natural sources and artificially. We have found that this treatment effects a true fractionation of humic and hymatomelanic acids of natural origin, and that the substances brought into solution show close analogies with the lignosulphonic acids obtained in the bisulphite treatment of wood pulp. Salts of organic bases with the 'sulphonic acids' from one variety of humic acid have been made, and found to show distinct double refraction, indicating a tendency towards crystallisation. The proportion of insoluble residue from sulphur dioxide treatment varies markedly with different preparations of humic acid, and its nitrogen content is not appreciably different from that of the original material.

These results suggest strongly that there is a close relationship between natural humic acids and lignins. It is, however, not yet possible to say whether this is due merely to the presence of unchanged lignins in natural humic acid preparations, or whether humic acids themselves are actually chemically related to lignins. Further work is in progress with the aim of deciding this question, together with the closely related question of the state of the nitrogen in natural humic acids.

C. E. MARSHALL.
H. J. PAGE.

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Intensity Distribution in the Fine Structure of the Balmer Lines.

IN the course of an investigation of the fine structure of the Balmer lines, at present being undertaken in this Laboratory, certain preliminary results of an apparently novel character have been obtained which seem to be of considerable interest. These refer to the dependence of the relative intensities of the two components λ' and λ'' of $H_\alpha[\lambda' < \lambda'']$, referred to in a recent letter in NATURE (Jan. 29, p. 163), upon the conditions of the discharge and in particular upon the diameter of the tube in which the discharge takes place.

Three discharge tubes were used. In the first the average diameter of the capillary was 0·16 cm. The intensity ratio of λ'' to λ', about 3 : 1 in this tube, was not appreciably dependent on either pressure or current density. The average diameter of the second tube was 0·6 cm. In this case the intensity ratio, now approximately unity, was, in agreement with Hansen's results (*Ann. d. Phys.*, 78, p. 558; 1925–26), primarily dependent upon the gas pressure and to a less degree upon the current density.

In an attempt to elucidate the striking difference between the results obtained in the above cases, an apparatus consisting of a tube of average diameter 0·6 cm. fixed axially with a second of about 0·9 cm. diameter was constructed. The apparatus was arranged so that independent discharges could be sent through the axial tube and through the space between it and the outer one (about 1 mm.), the pressure being the same in both. In the former, the intensity ratio was again dependent upon the gas pressure and current density, as it was in the second tube; in the latter, the intensity ratio was practically constant, and of the same magnitude as it was in the first tube.

G. E. HARRISON.

Physical Laboratory,
University of Birmingham, Feb. 7.

Electro-deposition of Rubber.

IN the description of the process of electro-deposition of rubber given in NATURE of Jan. 22, pp. 129 and 130, there occurs one statement which might be misleading to those not actually acquainted with the process. After reference to certain operating conditions it is said, "Against these advantages must be set the fact that, since rubber is a non-conductor, it is possible to obtain only comparatively thin sheets of rubber product, though further investigation will doubtless remove this limitation."

Although, of course, rubber is a non-conductor, the deposit of latex rubber particles, with or without other filling material, forms a spongy gel which is still permeated by the intermicellar liquid, which, of course, is an electrolytic conductor. Consequently the electro-deposited rubber is not actually an insulator, but is perfectly analogous to a porous diaphragm electrolytically connected with a metallic anode. Such limitations as exist in regard to the thickness of coating depend mainly on other conditions, therefore, than the formation of an insulating layer.

S. E. SHEPPARD.

Eastman Kodak Company,
Rochester, N.Y., Feb. 5.

The Survey of the Stars.[1]

By J. H. Jeans, Sec. R.S.

At the dawn of civilisation, when man awoke from his long intellectual slumber, nine muses were appointed to preside over his various activities. Only one muse was allotted to science, and that one was allotted to astronomy. Perhaps the high gods of Olympus who arrange these things had heard of no science beyond astronomy, or perhaps they thought it the only one worth encouragement; we do not know. But it is said that since then the claims of other sciences have been admitted, and a vast crowd of junior muses have been appointed to look after them. When they all meet in conclave, many of the latter report quite extraordinary rates of progress in their particular sciences, and it has sometimes been thought that astronomy, which started first in the race, has at times shown some tendency to lag behind.

To this Urania has always had a ready answer. She can point first to the immensity of her task; sciences such as geography, geodesy, and geology, whose field of action is limited to the surface of one tiny planet, can no doubt claim to be well on towards the completion of their tasks, but the exploration of an entire universe offers a task of a different order of magnitude. She can point also to the extraordinary difficulty of this task; after once the first obvious steps have been taken, the astronomer can get nothing of value except with instruments of almost incredible precision. Moreover, instead of being able to investigate phenomena when he pleases, he has to wait on Nature, and Nature moves very slowly in comparison with human life—the whole age of astronomy, as a science, bears the same relation to the ages of the stars that it studies, as does the last tick of the clock in the dying century to the century itself. Finally, she has often been heard to remark, with a mixture of pride and sorrow in her voice, that her science presents problems of such enthralling interest that only too few astronomers can be found to do their fair share of the fundamental work on which all progress must ultimately be based. We can rest assured that she is well satisfied when, as on the present occasion, our Society signals out for its highest honour one who has done not only a fair share, but also a lion's share, of most valuable fundamental work.

To the ancients the intrinsic difficulties of astronomical science did not loom large. The age of the universe meant much the same thing to them as the age of the human race, and the size of the universe was believed to be of the same order of magnitude as the size of the earth. The moon, they agreed, was about the size of the Peloponnese; the sun, as any one could see at an eclipse, was rather bigger. Aristarchus of Samos had, it is true, calculated that it must be eighteen or twenty times bigger, and had maintained that the fixed stars must be very remote indeed. But he was far in advance of his time, even believing that the earth moved round the sun. The majority of the early astronomers held that the spheres of the moon, sun, planets, and fixed stars were all packed fairly closely together. For the most part they believed firmly in the principle they described as 'the economy of Nature,' which prohibited the leaving of any unnecessary unoccupied space between the heavenly bodies—surely no scientific belief has ever been so utterly unwarranted by the facts! With this supposed principle firmly rooted in their minds, they naturally felt confident that it was a simple matter to determine the distances of the various heavenly spheres with fair accuracy. Later, when the determination did not prove so easy as had been anticipated, it began to be felt that the impossibility of discovering any parallactic motion whatever—any apparent change, that is, in the positions of the nearer stars as the earth performed its journey round the sun—presented an objection of real force against the Copernican system of astronomy.

It was on the absence of parallactic motion that Ptolemy had based his argument that the earth was the unmoving centre of all the celestial spheres, and as century after century rolled by and no trace of parallactic motion was forthcoming, it almost began to look as though Ptolemy had been right after all. Hooke, Römer, and Bradley, realising the fundamental importance of the question, attempted in turn to detect parallactic displacements of the stars, and all their efforts ended in failure, although we must remember that Bradley's failure immediately resolved itself into a triumph—the discovery of aberration. This provided convincing evidence of the earth's orbital motion, but threw no light on the question of the distances of the stars.

Early in the seventeenth century, Kepler had maintained that the stars were probably of the nature of suns, and that our sun was similar to the other stars. The observation that the brightest of the stars appear, in modern terminology, some 25 magnitudes (10^{10} times) fainter than our sun, might well have suggested that the nearest of the stars must be some 100,000 times as distant as our sun, and so must have a parallax of the order of, at most, two seconds of arc. But, so far as I know, this type of argument scarcely appeared until Newton advanced it in his "System of the World." From the observed size of Saturn's disc he calculated that the sun must emit in all $2 \cdot 1 \times 10^9$ times as much light as falls on Saturn. Although Saturn cannot re-emit all the light it receives, it appears rather brighter than a first magnitude star. Thus if the first magnitude stars are as luminous as the sun, they must be more than $\sqrt{(2 \cdot 1 \times 10^9)}$ as distant as Saturn. Newton conjectured their distance to be about 100,000 times that of Saturn, representing a parallax of $0'' \cdot 21$—that is to say, he estimated that the first magnitude stars would appear to swing through an angle of only 0·42 seconds of arc in the sky as the earth moved from one end of its orbit to the other.

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[1] From an address delivered to the Royal Astronomical Society on Feb. 11, referring to the award of the Gold Medal of the Society to Prof. Frank Schlesinger for his work on stellar parallax and astronomical photography.

Almost at the same time the converse of this argument began to appear. Although Bradley had not succeeded in obtaining a definite parallax for any star, he had proved in 1727 that that of γ Draconis could not exceed one second of arc. Assuming this result to be generally true for all stars, astronomers began to compute lower limits to the luminosities of the brighter stars and found that they were commensurate with that of the sun, as Kepler had maintained. In 1800 Herschel used this supposition to compute hypothetical parallaxes both for bright and for faint stars.

The year 1838 saw the whole situation suddenly transformed. For in that year Bessel, Struve, and Henderson independently found definite and distinctly different parallaxes for the three stars 61 Cygni, α Lyræ, and α Centauri, and it first became possible to assert, on incontrovertible evidence, that the stars were not all at the same distance from the earth. It was now for the first time conclusively proved that the system of the stars formed a three-dimensional and not a two-dimensional structure. A workable method had been found for sounding the depths of space, and the universe lay open for exploration.

The general feeling of astronomers at the time is well shown in the address delivered by Sir John Herschel when, eighty-six years ago, he handed our gold medal to Bessel. He said: "I congratulate you and myself that we have lived to see the great and hitherto impassable barrier to our excursion into the sidereal universe, that barrier against which we have chafed so long and so vainly—*aestuantes angusto limite mundi*—almost simultaneously overleaped at three different points. It is the greatest and most glorious triumph which practical astronomy has ever witnessed. . . . Let us trust that, as the barrier has begun to yield, it will speedily be effectually prostrated."

The difficulties of the problem were so great as to put out of the question any such speedy prostration of the barrier as my predecessor of eighty-six years back appears to have hoped for. Although astronomical ability of the highest order was brought to bear, progress was slow. In 1901 Newcomb compiled a catalogue of stars of known parallaxes; their total number is only 72, of which 15 are designated as being "subject to more doubt than usual," while one is damned with four little dots which, we are told, means that it is "entirely unreliable." Even including the unreliable parallaxes, astronomy had been exploring the universe thrown open to it sixty-three years earlier at the rate of only about one star a year. The appearance of Newcomb's table, however, marked the darkest hour before the dawn.

Within two years Schlesinger begun publishing photographic determinations of parallax, which showed a far higher level of accuracy than had hitherto been either attained or thought possible. Other astronomers speedily adopted photographic methods, and in due course a scheme of co-operation was arranged between the seven observatories of Allegheny, Dearborn, Greenwich, McCormick, Mount Wilson, Sproul, and Yerkes. The results of this scheme of work up to the year 1924 are contained in Schlesinger's "General Catalogue of Parallaxes." This contains the parallaxes of 1870 stars to a very high degree of accuracy, and forms one of the most useful and valuable publications the working astronomer has ever seen. A comparison of this catalogue of 1870 parallaxes with Newcomb's 1901 Catalogue of 72 parallaxes gives a vivid picture of the work done in twenty-three years. While Newcomb's parallaxes show an average error of nearly a twentieth of a second, those in the Schlesinger catalogue seldom show a probable error of more than a hundredth of a second—the angle subtended by a pin-head at a distance of twenty miles! The gain in accuracy is the greater part of a decimal place, while the Schlesinger Catalogue contains twenty-six times as many stars as the earlier list.

Let us turn from this record of work achieved, to contemplate the realms which remain to be conquered. In measuring the distances of the stars, the natural unit of length is the 'parsec,' the distance of 19,100,000 million miles, at which a star has a parallax of one second of arc. There is no known star within one parsec of the sun. The number of known stars within spheres of radii 2, 3, 4 parsecs, drawn round the sun as centre, is 3, 6, 18 respectively. In this count binary systems are treated as single stars, although Proxima Centauri is deemed to be distinct from α Centauri, and the sun is not counted since its presence is a prerequisite to our making the calculation at all. Now if the stars in the neighbourhood of the sun were scattered at random, and were all known, the number of stars observed to lie in different spheres would be proportional to the cubes of their radii; if they were not all known, there would of course be a falling off from this law for the spheres of greatest radii, since distant stars are more likely to remain unknown than near stars. In particular, if the 18 known stars were the total inside a sphere of 4 parsecs radius, the numbers to be expected inside the three spheres of radii 2, 3, and 4 parsecs would be 2·2, 7·6, and 18 respectively. These are near enough to the actual numbers of 3, 6, and 18 to justify the hope that the great majority of the stars within 4 parsecs are known. But 4 parsecs is the greatest distance for which such a hope can be entertained. With 18 stars lying within 4 parsecs of the sun, there ought to be a further 17 lying at distances between 4 and 5 parsecs: only 6 such stars are known. There ought to be about 280 within 10 parsecs: Schlesinger's Catalogue contains only 86.

Thus even now our survey of the universe is tolerably complete only to a distance of about 4 parsecs; beyond this the number of known stars increases nothing like so rapidly as the cube of the distance. With present-day accuracy, trigonometrical parallaxes can be estimated to a probable error of, let us say, 0″·008, so that the parallaxes of stars within 100 parsecs may be said to have a real physical significance. Of such stars there ought to be about 281,250, and at the present rate of progress the determination of their parallaxes would occupy astronomy for fully 1000 years to come.

Just now we compared astronomy's past 3000 years of existence to the last tick of the clock in a dying century; we may with equal justice compare the 3000 years next to come to the first tick in a new century—such is the proportion it bears to the total time our present stars may be expected to last. Looked at on this scale there may be thought to be plenty of time for a really exhaustive survey of the universe, and past progress may be accounted amazingly rapid. In one tick of the clock astronomy has come to birth, has developed the most difficult and accurate technique known to science, and has surveyed the universe, accurately and completely to 4 parsecs, and sketchily and imperfectly beyond. The next tick of the clock should see the accurate survey extended to well beyond 100 parsecs, and astronomy has a whole century of life before it. I fear there may be a fallacy involved in the adoption of this point of view; it is that we do not know how long the human race will endure. At the very longest estimate, man has only existed for a hundred ticks of our clock, civilised man for only two or three, so that our race and civilisation would alike seem to be at the very beginning of their existence. Yet he would be a bold extrapolator who would assert with confidence that man is good for another three thousand million ticks of our clock on the ground that, if nothing unforeseen happens, the present stars will still be in existence at the end of that time. When we take a time-scale in terms of individual lives, we may still feel gratified at past progress, yet we cannot but feel awed by the magnitude of the task that remains.

On Rejuvenation.

Few human beings will view the approach of old age with philosophic calm, so that any method by which the period of maturity may be prolonged and the onset of senility delayed will always arouse widespread interest and discussion. Within the last few years a considerable amount of attention has been directed to the subject of rejuvenation, following certain somewhat sensational operations on human beings and the higher apes. Although there is no doubt that the internal secretions of the genital glands exert a pronounced effect upon the rest of the body, yet it is by no means certain that old age can be attributed solely to their degeneration: in fact, the cells of the body as a whole suffer decay, so that it is probable that an operation affecting only one of the organs of the body, only one, moreover, of the number which influence the activities of the other cells throughout life, would have no more than a temporary effect at best.

Although removal of the genital glands has a profound influence upon the mentality and bodily structure of the subject, yet evidence as to its effects upon strength and endurance has been conflicting. M. D. Sumulong, in a recent paper (*Philippine Jour. Sci.*, Mar. 1926, p. 327), from experiments on guinea-pigs, concludes that castration is without definite influence upon their pulling power or endurance. Yet one of the characteristic results of a rejuvenating operation has been the increased physical vigour of the subject, suggesting again that decay of the genital glands is not the sole factor in old age. Finally, in discussing the results of human experiments, it is difficult to know how far the element of suggestion must be taken into consideration.

Various operations have been proposed for rejuvenating purposes; thus transplantation of the gland from another individual of the same, or a closely allied, species has been effective, especially in the female. In the male, the ligation of the efferent duct from the testicular gland has been advocated as a much simpler, withal as effective, a procedure. It is of interest to note that the flatworm Planaria can be rejuvenated by starvation. It shrinks to one-quarter its adult size and becomes young again: if fed, it grows up: the process can be repeated indefinitely and the organism's life may be prolonged to twenty times the ordinary length (F. A. E. Crew, *Nineteenth Century*, Feb. 1927, p. 225). The infinitely more complex structure of the higher animals, however, prevents the recourse to such a simple expedient.

The justification for the operation of ligature of the efferent duct of the testes, or *vasoligation* as it is called, depends on the assumption that this procedure causes degeneration of the sex cells proper, thus permitting the interstitial cells to hypertrophy, with a consequent increase in the amount of the internal secretion produced by them. It might not even be necessary for them to hypertrophy: with degeneration of the sex cells the nutriment supplied to the whole gland by the blood stream might be sufficient for the full activity of the internal secretory cells, whereas with the sex cells present the former might fail to obtain all the food they required owing to the competition of the latter. In the period of full maturity both types of cells are probably sufficiently supplied by an efficient circulation.

Oslund has stated that vasoligation does not lead to degeneration of the sex cells unless the testis moves from its usual position in the scrotum into the abdomen. Y. Tamura and F. A. E. Crew, in experiments on the mouse (*Proc. Roy. Soc. Edin.*, 1926, vol. 46, p. 283), find that this operation is followed by degeneration of the sex cells, provided sufficient time has elapsed before the testis is examined. If the epididymis is removed, degeneration occurs much earlier. On the other hand, in neither case was the degeneration complete. The evidence, however, favours the assumption on which the operation of vasoligation is based.

From what has been said above, it is clear that the two functions of the testis are to a certain extent independent. Thus an individual may be rejuvenated, without at the same time becoming capable of begetting offspring. This would naturally occur if vasoligation was performed on both sides. The unilateral operation, or gland transplantation, on the other hand, might lead to renewed activity in the individual's own glands, with the production of spermatozoa and a further period of fertility.

In the female, apart from gland transplantation, which may lead to renewed activity in the individual's own ovaries, the sex cells may be destroyed by irradiation with the X-rays; in the latter case rejuvenation, due to increased activity of the interstitial cells of the ovary, is of course accompanied by sterility.

One other possible method of the future may be mentioned, and that is rejuvenation by the administration of potent extracts from the sex-glands. In the case of the female, the hormone which produces 'heat can be extracted in a, probably crude, condition from the ovaries of a number of animals and is effective on subcutaneous injection. No such active extract has yet been obtained from the testis. At any rate, the effect of the former upon the general bodily condition has not yet been studied.

By some one of these methods, used in time, it may become possible to prolong the span of life. In the case of the rat, death has been postponed for a period equal to one-fourth its average length of life. No information is available in the case of man, but it is claimed, as Crew points out, that senility in a rejuvenated individual is sudden, and death, when this phase of life is reached, soon supervenes.

Obituary.

Colonel C. H. T. Marshall.

COL. CHARLES HENRY TILSON MARSHALL died in London on Jan. 20 in his eighty-sixth year. He was born on July 8, 1841, and was the eldest son of W. Knox Marshall of Hereford. He entered the Indian Army in 1859, and on arrival in India was attached to the 35th Royal Sussex Regiment. On leaving this regiment he joined the 3rd Sikhs, Punjab Frontier Force, but saw little military service, being appointed in 1865 to the Punjab Commission. After filling various appointments with exceptional ability, he was finally made Assistant Commissioner of Lahore, retiring in 1896.

Col. Marshall was best known to Indian and other ornithologists not so much as a scientific worker but as a field naturalist. Wherever he was posted, and his districts were many, he made copious observations and notes on the local birds, and it was his extensive knowledge of game birds and his high reputation as a small-game shot that induced Hume to obtain his collaboration in the "Game Birds of India" in 1879. The three volumes composing this work are full of Marshall's field notes, and the business portion of the work, such as arrangement of plates, etc., also fell to his share. Marshall was, however, never fond of publishing his vast stores of bird lore, and never brought out any book in his own name alone for the benefit of his brother workers. At the same time, "Stray Feathers," Hume's journal of ornithology, which ran through eleven volumes, contains many of his notes, which also appeared from time to time in other Indian papers and journals. In 1877 his brother, then Capt. G. F. L. Marshall, R.E., brought out a book entitled "Bird Nesting in India," and in this volume much of the valuable information compiled was obtained from Col. Marshall. They were also associated in bringing out "The Monograph of the Capitonidæ or Scansorial Barbets," 1870. Their name has since been given to one of the most beautiful of Indian barbets, *Megalæma marshallorum*.

After his retirement in 1896 Col. Marshall returned to England, and since that date, with the exception of a few articles in English papers, he ceased to write upon ornithology. His brother, General Marshall, who survives him, is, of course, well known to ornithologists and botanists not only in India but also elsewhere. His son, Dr. G. A. K. Marshall, is now Director of the Imperial Bureau of Entomology.

We regret to record the death on Feb. 18, at Oxford, in his seventy-fifth year, of Mr. Frederick Eden Pargiter, the well-known oriental scholar. Mr. Pargiter was educated at Taunton Grammar School and Exeter College, Oxford, where he took a first class in both Moderations and the final schools. He was also Boden Sanskrit scholar. He entered the Indian Civil Service in 1876 and served as district and sessions judge and was a judge of the Calcutta High Court, retiring in 1906. He was an active member of the Asiatic Society of Bengal, of which he was successively secretary and president. On his retirement, he became closely associated with the work of the Royal Asiatic Society, serving for some years on its council and later becoming one of its vice-presidents. In his oriental studies he showed great originality. His "Dynasties of the Kali Age," published in 1913, was a work which initiated the critical study of the semi-historical, semi-legendary Puranas. This study he carried further in his annotated translation of the Markandeya Purana and "Ancient Historic Indian Tradition." He was a frequent contributor to *Epigraphia Indica* and prepared for the press the centenary volume of the Royal Asiatic Society issued in 1923.

We regret to announce the following deaths:

Dr. A. W. Crossley, F.R.S., who had just resigned the post of Director of the British Cotton Industry Research Association, on Mar. 5, aged fifty-eight years.

Dr. Ira Remsen, president emeritus of Johns Hopkins University, Baltimore, who was largely responsible for the organisation of chemical teaching and research in the United States, and was also the author of well-known text-books on chemistry, aged eighty-one years.

News and Views.

The Trustees of the British Museum have appointed Mr. Charles Tate Regan to be Director of the Natural History Departments of the British Museum in succession to Sir Sidney F. Harmer, who retired from office on Mar. 9. Mr. Regan was born in 1878 and was educated at Derby School and at Queens' College, Cambridge. He graduated with a first class in Part I. of the Natural Sciences Tripos in 1900 and obtained a second class in Part 2 in 1901. He joined the staff of the Natural History Museum in 1901 as assistant in the Department of Zoology and was placed in charge of the collection of fishes. The care of this unrivalled collection opened before him an extensive opportunity for research, of which he took full advantage, and he soon established himself as one of the leading ichthyologists of the day. He has written many memoirs on fishes—as well as reports on the fishes of Central America and the Antarctic —and is the author of a book on "British Freshwater Fishes." He was elected a fellow of the Royal Society in 1917. He was president of Section D at the Southampton meeting of the British Association in 1925, and selected "Organic Evolution" as the subject of his address. He was exempted from military service during the War on account of the important work which he was doing on the Freshwater Fish Committee. At the time when he entered the Museum, the other members of the Zoological Department were much senior to him in years, and as many of them had no desire to undertake administrative work, he secured early promotion. In 1919, on the retirement of Mr. W. R. Ogilvie-Grant, he was appointed Assistant Keeper (or Deputy Keeper, as the office is now styled), and in 1921, when Sir Sidney Harmer became Director, he succeeded him as Keeper of Zoology. He now succeeds him in the highest office of the Museum, and to him falls the task of advising the Trustees on the work of the Museum and on the course that may provide the best solution of the difficulties arising from the present congestion in the buildings at South Kensington.

With the announcement of the appointment of Mr. Tate Regan as Director of the Natural History Museum comes that of the promotion of Dr. William Thomas Calman to succeed him as Keeper of Zoology. Dr. Calman was born in 1871, and was educated at Dundee High School and at University College, Dundee, in the University of St. Andrews. He graduated B.Sc. in 1895 and D.Sc. in 1900. From 1895 until 1903 he was assistant lecturer and demonstrator in zoology at University College, Dundee, and in 1904 he was appointed assistant in charge of Crustacea in the Natural History Museum. On this subject he is a recognised authority, and is the author of many books, memoirs, and articles dealing with it: for his researches he was elected a fellow of the Royal Society in 1921. He was appointed Deputy Keeper of Zoology in 1921. He is zoological secretary of the Linnean Society and secretary of the Ray Society. Dr. Calman is a man of culture and has a wide knowledge of zoology; he may therefore be expected to stimulate the multifarious work of his Department.

Great interest has been aroused in the celebrations arranged by the Yorkshire Branch of the Mathematical Association in connexion with the two hundredth anniversary celebrations on Mar. 18-20 of the death of Sir Isaac Newton, and a large number of representative mathematicians and others have intimated their intention to participate. Close on two hundred visitors will go to Grantham for the scientific bicentenary meeting to be held at the Old School, King's School, Grantham, on Saturday morning, March 19. This is the room in which Newton studied as a schoolboy. The meeting will be presided over by Dr. J. H. Jeans, and will be addressed by the Master of Trinity, the Astronomer Royal, Prof. G. H. Hardy, and Dr. Horace Lamb. After lunch the company will visit Woolsthorpe Manor House where Newton was born, and will be entertained to tea at Stoke Rochford by Mr. Christopher Turnor. The celebration dinner in the evening will be attended by many local people; the Master of Trinity will preside, and Prof. Whittaker, the Bishops of Birmingham and Lincoln, the Master of the Mint, and others will deliver addresses. It is expected that several interesting speeches referring to Newton's life and work will be made at the dinner. The mayor of Grantham is inviting all the visitors to a civic reception at the Guildhall, Grantham, on Friday evening, Mar. 18. The mayor and other civic officials will join the visitors in a procession from the Guildhall to the Grantham Parish Church on the Sunday morning, Mar. 20, for the special bicentenary service at which the Bishop of Birmingham will preach, and the Bishop of Lincoln will also be present.

The Judicial Committee of the Privy Council has delivered judgment in the boundary dispute between Canada and Newfoundland. This involved several thousand square miles in the interior of Labrador. The dispute centred round the meaning to be attached to the expression "coast of Labrador," which in the eighteenth century was granted by proclamation and royal commission to Newfoundland. Canada contended that it referred merely to a coastal strip of sufficient depth inland to meet the needs of the fishing population, and proposed one mile from deep water as the limit. Newfoundland interpreted it as meaning all the territory drained by westward-flowing rivers. The importance of this inland elevated area lies in its timber resources and reported iron-ore deposits. Judgment has been given in favour of Newfoundland, and the boundary is defined as a line drawn due north from "Blanc Sablon Bay to the 52nd parallel of north latitude, thence westward along that parallel to the Romaine River, then northward along the left bank of that river and its head waters to their source and from thence due north to the west of the water-shed or height of land there, and from thence westward and northward along the west of the watershed of the rivers flowing into the Atlantic Ocean until it reaches Cape Chidley." Thus the whole Hamilton River system, with its floating ways for timber and its great water-power resources, is added to Labrador. The judgment is, in effect, a recognition of the principle that a coast region cannot be economically separated from its hinterland.

Prof. H. E. Armstrong delivered the Horace Brown Memorial Lecture before the members of the Institute of Brewing on Feb. 25, and was presented with the memorial medal shown in the accompanying illustration (Fig. 1). In the course of his lecture, Prof. Armstrong gave an outline of Horace Brown's life and scientific career. The feature in his early career was his devotion to the study of scientific subjects in his out-of-school time. He entered the College of Chemistry in Oxford Street, London, then under the celebrated Hofmann, in the spring of 1865. Prof. Armstrong joined the school at the same time and the two students became fast friends for life. After only six months professional training, when scarcely 17½ years old, Horace Brown entered as junior brewer into Worthington's Brewery at Burton. In 1875 he was made manager of the manufacturing department and held this post until 1889, when he became a managing director. He retired in 1893, but only to devote himself to consulting work and original inquiry. Horace Brown gradually introduced scientific methods into brewery practice and was a pioneer in making brewing subject to scientific control. His scientific researches led to his election into the Royal Society in 1899. He was awarded the Longstaff medal of the Chemical Society in 1894, a Royal medal of the Royal Society in 1903, and finally the Copley medal of that Society in 1920—the highest scientific distinction in Great Britain. He died on Feb. 6, 1925. Horace Brown's early work was built largely upon the foundation laid by the great Pasteur. An industry, the lecturer said, which has had within its fold men of such nobility of outlook and penetrative power, has reason to be proud and to take pride in its potential status among the comity of professions. The industry is one affording special opportunities of studying the life process. In instituting the lectureship, the Institute of Brewing representatives of the brewing industry have held out the right hand of fellowship to the scientific fraternity, especially to physiological inquiry.

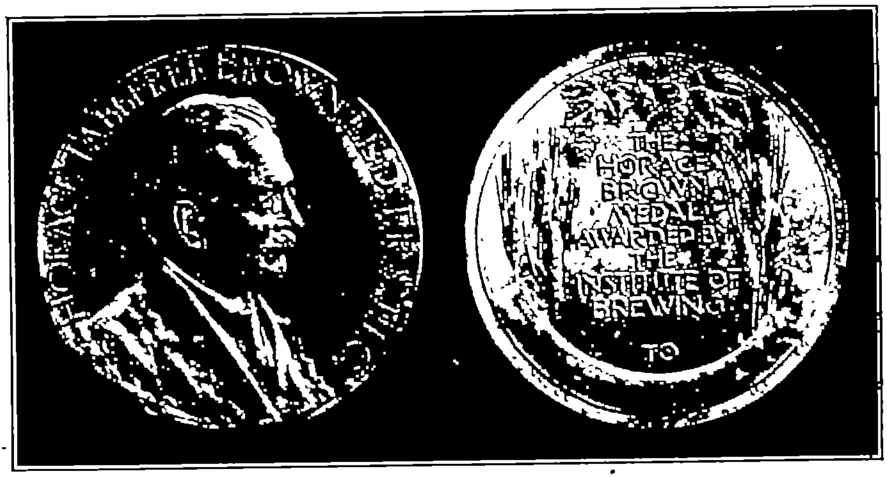

Fig 1.—Horace Brown Memorial Medal (natural size). Upon the medal presented on Feb. 25 were inscribed the words: "Henry Edward Armstrong, LL.D., F.R.S."

The subject of Prof. A. S. Eddington's eighth Gifford Lecture in the University of Edinburgh on Friday, Mar. 4, was 'World-building.' After a consideration of modern views of this subject he gave an account of some of the ideas underlying the 'new quantum theory' which could necessarily involve changes not yet formulated in the scheme of world-building. He said the conflict between quantum theory and classical theory becomes most severe in the problem of the propagation of light. Here it becomes in effect a conflict between corpuscular theory and wave theory. There is no serious doubt as to the ultimate source of the conflict; the classical (including the relativity) view of space and time is inappropriate in dealing with a single quantum. A single quantum has not travelled 50 billion miles to us from Sirius; it has not travelled for eight years. To apply these phrases to *one* quantum is like reading the Riot Act to one man. Somehow, when enough quanta are present to form a quorum, we shall be able to find among their statistical properties the genesis of the conceptions of distance and duration. But at present we are unable to make a start with such a reconstruction. As a condition for treating the subject in space and time, it seems necessary to allow that wave properties and particle properties are not inconsistent. Thus we find that in the new developments, not only do the waves of light seem to have corpuscular properties, but also reciprocally the corpuscles of matter are found to have wave properties. Long ago phenomena of diffraction of light were observed which ruled out a purely corpuscular theory of light; and it seems that, to-day, phenomena of diffraction of matter are being observed which rule out a purely corpuscular theory of matter.

In continuation of the series of lectures being delivered at Bedford College, London, Prof. H. H. Turner spoke on Mar. 1 on "Conceptions of the Cosmos in the Galilean and Newtonian Period." The period with which Prof. Turner dealt was characterised by a complete breakaway from old ideas. The beginning of the secession was evident in the work of Galileo (1564–1642) and Kepler (1571–1630), but Newton (1642–1727) crowned it by making a new orthodox system to account for the motions of the earth and the heavenly bodies. Galileo is chiefly remembered in connexion with the telescope, but he also made two great discoveries. By observation of the hanging lamp in Pisa Cathedral he found that the time of swing of a pendulum is approximately independent of the angle through which it swings. By experiments from the Leaning Tower of Pisa he found that a heavy and a light body dropped at the same instant from the same height will reach the ground almost simultaneously. This was directly contrary to the generally accepted theory, due to Aristotle, that the time of fall varies inversely as the weight of a body, and brought Galileo into conflict with the Church and the philosophers of his time. Kepler, assisted by the extraordinarily accurate observations of Tycho Brahe, contributed his three laws of planetary motion, but it was left to Newton to account for all these phenomena by his universal law of gravitation. He first proved in 1665 that Kepler's third law (on the periodic times of the planets) fitted in with the assumption of an attraction according to the inverse square law. He then proved that a heavenly body attracted in this way by the sun, will move in an ellipse with the sun at one focus. His great difficulty then was the problem of the attraction of a sphere on a body just outside it, assuming that every particle of matter attracts every other particle according to the inverse square law. It was not until 1685 that he proved, very elegantly, that a sphere attracts like a particle at its centre, and thus accounted to his satisfaction for the falling apple. The "Principia" was published in 1687 at Halley's expense, and it is largely due to his encouragement that the world was able to learn of Newton's discoveries.

A memorial tablet to the late Sir Patrick Manson, who has been aptly termed "The Father of Tropical Medicine," will be unveiled by the Minister of Health, the Right Hon. Mr. Neville Chamberlain, on Mar. 15, at 3.30 P.M., at the Royal Albert Dock Hospital. This tablet has been erected by the Seamen's Hospital Society to commemorate the great services of Sir Patrick Manson to that Society as well as to the cause of science. Sir Patrick was elected physician to the Society in 1892, and laboured almost continuously in its service for twenty years until he retired in 1912. It is a most appropriate position for this memorial in the spacious ward of the Albert Dock Hospital now known by his name, where Manson conducted his clinical teaching and where a great many of his well-known researches were carried out. It was in the Royal Albert Dock Hospital, in fact, after some seven years' intensive labour, that the London School of Tropical Medicine was founded, with the active aid and encouragement of Mr. Joseph Chamberlain; and it was the association of these two great men that has made tropical medicine stand for what it does to-day in the British Empire. It is therefore appropriate that his son, Mr. Neville Chamberlain, should unveil this memorial in the wards of the Seamen's Hospital under the auspices of that great Society which has done so much to encourage and foster the teaching of tropical medicine in Great Britain.

Some account of Manson's life and work appeared in our columns shortly after his death (May 6, 1922, p. 587). The portrait medallion in the memorial tablet is the work of Mr. T. R. Pinches, of Albert Embankment, London, and is the original plaque from which the Manson medal, now the property of the Royal Society of Tropical Medicine and Hygiene, has been struck. The original idea of a memorial medallion emanated from a committee which assembled shortly before Manson's death (April 9, 1922) to raise subscriptions from Manson's old friends and fellow-workers for a presentation portrait. After defraying expenses, the surplus of the fund was devoted to the execution of this medallion. The portrait was obtained by the artist shortly before Manson's death and is considered a specially good likeness, portraying, as it does, in a pleasing manner, the rugged but kindly face of this great teacher and investigator. It is well, now that Manson's school has been moved to the centre of London and is about to expand beyond his most ambitious dreams, that this Manson memorial should rest, where he first founded it, in the charge of the Seamen's Hospital Society at the Royal Albert Dock.

An interesting association of science with literature was approved a few days ago, when the West Sussex County Council accepted the sum of £500 as a Shelley Memorial Trust. The income from this fund is to be used for prizes to pupils in schools in the county who have been most successful in the study of science subjects, "special preference being given to boys and girls who express themselves with literary ability." Shelley was born at Field Place, near Horsham, Sussex, on Aug. 4, 1792, and the centenary of his birth was celebrated in the county in 1892. Mr. J. J. Robinson and Mr. J. Stanley Little, the trustees of the fund then raised, have now handed over the residue to the County Council for the purpose stated. It was a happy thought to establish school prizes for literary style combined with knowledge of Nature; and it is most appropriate that Shelley's name should be associated with them. His "Queen Mab," for example, and his notes upon this and other poems, reveal a knowledge of astronomy unusual in poets and of beauty in expressing it, while "The Cloud" is a perfect picture of a natural theme. Since his time, our conceptions of the universe, and of the constitution of the radiant orbs in it, have been greatly extended, but there is only one poet to-day—Mr. Alfred Noyes—who has found in it a source of inspiration. We welcome, therefore, the encouragement to be given to young people in Sussex to think of truth and beauty together instead of things apart.

SIR HERBERT JACKSON delivered the Friday evening discourse at the Royal Institution on Mar. 4, when he discussed some colouring agents in glasses and glazes. Out of a large number of colouring agents for glasses and glazes, copper and iron were chosen as illustrations. Metallic copper dispersed through a glass in an extremely fine state of division gives a clear transparent red glass. With progressively larger particles a semi-transparent red glass can be obtained or a glass which is blue to look through and red-brown by reflected light. With still larger particles the glass in thin layers is of a grey neutral by transmitted light and a pronounced brown-red by reflected light. Cuprous oxide was used by the Egyptians to produce a brilliant scarlet glass, the colour of which is due to comparatively large crystals of cuprous oxide. Specimens of early glass, presumably of Saxon origin and of an orange-yellow colour, also owe their colour to cuprous oxide, but in its yellow form. Only recently has it been possible to reproduce these glasses on a laboratory scale. The colours produced by cupric oxide are transparent blues and greens, the precise colour being determined by the amount of cupric oxide present, the composition of the glass, and the temperature at which it is made. Ferric oxide gives yellows, browns, and brownish reds, which are attributed to various concentrations and states of dispersion of this oxide. Ferrous oxide as a colouring agent produces blues and greens according to the composition of the glass, and to it can be attributed the beautiful tints found in certain Chinese glazes. Ferroso-ferric oxide (magnetic oxide of iron) gives neutral tints of various depths, and with high concentrations a black glass can be obtained. If the concentration of the oxide be high enough, some of the oxide will come out in cooling so as to be dispersed through the glass in very minute aggregations, which are, however, presumably crystalline, since the resulting glass is appreciably magnetic.

MR. T. L. ECKERSLEY, who has for several years been experimenting on short-waves for the Marconi Co., read an important paper on short-wave radio telegraphy to the Institution of Electrical Engineers (Wireless Section) on Mar. 2. As the paper is both theoretical and experimental, it will prove of interest to many. The agreement between practice and the ordinary theory is far from satisfactory. Some propose to use aerials which radiate their energy upwards so as to take advantage of the conducting layer. The Marconi Co. radiates its beam horizontally with a vertical polarisation. Some Americans prefer to use a horizontal polarisation. The author's experiments seem to indicate that low-angle transmission, that is, almost horizontal radiation, is the best. Cases have been known where the ray comes right round the world and affects a receiver relatively close to the transmitter. The ray which has gone round the world causes an echo which is heard about a seventh of a second behind the main signal. Experiments with very short wave-lengths prove that an aerial 7 metres in height is much less efficient than aerials of 35 metres and 70 metres height respectively. With low wave-lengths the author finds that the range increases very definitely with the square of the frequency, provided the wave-length is greater than 10 metres. At this wave-length, signals projected at a fairly high angle in Great Britain have little if any effect on a receiver at Buenos Ayres. They seem to leave the earth altogether. There is little doubt that the daylight range is a minimum for waves 200 metres in length. He concludes that in long-distance transmission the ray trajectory has a shallow angle of elevation of about 15° and follows the great circle path. His theory is essentially a modified form of the conducting layer theory.

THE British Museum (Natural History), to use the awkward official title, has issued the first number of a *Natural History Magazine*, designed to further natural knowledge by descriptions of important additions to the collections and of notable possessions in the galleries and cabinets. It is a welcome sign, taken with the creation of popular exhibits, the institution of popular demonstrations, and the issue of a wonderful series of picture post-cards, of the will of the Trustees to make special appeal to the intelligent but non-scientific public whose moneys support the institution. The first number contains a variety of articles dealing with particular items in the departments of zoology, entomology, geology, and botany—"Two Important Additions to the Collections of Beetles," "Tektites," "Rafflesia: the largest known Flower," "Sirens in Fancy and in Fact," to mention the first four. The articles are short and informative; they are severely limited in scope and are largely descriptive, so descriptive as to suggest occasionally the flavour of the text-book. The success of the magazine depends, we take it, upon the support of the public, and the public, greedy as it is nowadays of natural history information, demands the general as well as the particular, and above all likes the light touch. We suggest that at least one article in each number be reserved for a general theme, such as the exhibits are well fitted to illustrate, heredity, protective, sexual, or seasonal coloration, migration of fishes, or a score of others, and that too narrow a view should not be taken of the way in which the collections and the work of the staff can be best advertised. There could be no better model of a successful, attractive, and purposeful museum magazine than the parallel publication, *Natural History*, issued by the American Museum of Natural History.

CONFLICTING reports as to the extent of the earthquake which occurred in Japan on Monday, Mar. 7, at 6.28 P.M., have been received. It seems that a severe shock lasting about three minutes was felt in Nagoya, Kyoto, Osaka, and Kobe. In Osaka and Kobe, fires broke out and sea waves following the earthquake added to the disaster. A number of smaller towns have been destroyed. The seat of the disturbance appears to have been in the provinces of Tajima and Tango on the north side of the main island, Honshiu, some two hundred miles west of Tokyo and about fifty miles north of Kobe.

Prof. H. H. Turner, Savilian professor of astronomy at the University of Oxford, has been awarded the Bruce Gold Medal of the Astronomical Society of the Pacific, "for distinguished services to astronomy."

The Secretary of State has appointed the following as members of a joint committee for the management of the proposed Dairy Research Institute in Scotland: Sir Donald MacAlister (chairman); Prof. Robert Muir and Prof. D. Noël Paton, representing the University of Glasgow; Mr. C. Lindsay, Mr. John Speir, and Principal W. G. R. Paterson, representing the West of Scotland Agricultural College; the Right Hon. Lord Weir; and Mrs. Houison Craufurd.

Dr. W. Lawrence Balls has been appointed Director of the Botanical Section of the Egyptian Ministry of Agriculture. Meanwhile Dr. Balls is paying a short preliminary visit to Egypt, at the invitation of the Royal Agricultural Society, to advise that body on a proposed cotton research institute. It is of interest to recall that both these developments are the outcome of Dr. Ball's activities in the years 1904–14.

In an article in *Scientia* of January last on the dawn of modern biology, the tercentenary is commemorated of the birth of the illustrious and observant Italian biologist Francesco Redi. The long prevalent view that flies were generated in putrefying flesh was demolished by a few simple but fundamental experiments of Redi, who proved for the first time that the maggots in putrefying flesh were the product of eggs laid thereon by flies which visited it—a notable beginning of the long attack on the doctrine of spontaneous generation.

The managing director of the Amalgamated Wireless (Australasia) Ltd., telegraphs to the Marconi Co. that during the past three weeks the beam wireless station has been readjusted and now gives most satisfactory results. During two days, beam signals have been heard in Australia throughout the 24 hours. Two-way communication also at high speeds has been established daily for several hours on end, the maximum speeds equalling those obtained over the relatively short distance between England and Canada. During a continuous test of seven days, the average traffic capacity exceeded 60,000 words per day in each direction. As soon as the British official tests are completed, the service will be open for public traffic. The transmitting and receiving stations in England are at Grimsby and Skegness respectively; the Australian stations are near Melbourne.

The Prize Thesis submitted to the University of Edinburgh no less than sixty-seven years ago by Prof. W. Carmichael McIntosh has been reprinted (by Messrs. Paul and Matthew, Dundee, 1926). It is entitled "Observations and Experiments on Carcinus mænas," and it includes some most interesting notes on the natural history of this familiar crab. It contains also an account of the anatomy of the central nervous system, with observations on the effects of operative interference with the parts of these organs. A most curious description of the action of a number of narcotic and other poisonous substances on the living animal follows. There are four lithographic plates, which were drawn on the stone by the author. We congratulate Prof. McIntosh on this remarkable piece of research. There must be few scientific workers, still actively employed, who can look back on substantial investigation carried out so many years ago.

A discussion on the problem of the humane slaughtering of animals was held on Feb. 25 at King's College, London, under the auspices of the newly formed University of London Animal Welfare Society. Prof. Julian Huxley, who presided, contrasted the up-to-date public abattoir in which he had had occasion to work at Heidelberg with the old-fashioned little private slaughter-houses of Oxford, and Profs. J. M'Cunn and A. R. Smythe, of the Royal Veterinary College, while differing on minor points, agreed in recommending the use of the captive-bolt pistol as more humane than the old-fashioned methods employed in the case of 90 per cent. of the animals slaughtered in Great Britain. That view was vigorously opposed by a representative of the meat trades, but a resolution was passed calling upon the Government to appoint a commission of inquiry into the whole question.

At the forty-ninth annual general meeting of the Institute of Chemistry, held at 30 Russell Square, Prof. G. G. Henderson, president of the Institute, remarked that there appeared to be some abatement of the enthusiasm for chemistry as a career which was noted immediately after the War, although the roll of membership had increased by 242 during the past year, to a total of more than 5200. At present the supply of chemists in Great Britain exceeds the demand. In October next the Institute will celebrate its jubilee, and a medal and prize have been established in honour of the first president, Sir Edward Frankland, who held office from 1877 until 1880; the award will be made to a registered student of the Institute for the best essay on a set subject of professional, as opposed to technical or purely chemical, importance. The subject for the first essay will be "The Importance of Chemistry to the Welfare of the People." Prof. Arthur Smithells has been elected president of the Institute for the period 1927–28.

At a meeting of the Newcomen Society on Feb. 22, held at the Institution of Mechanical Engineers, papers were read by two French members, MM. Seguin and Achard, one dealing with "British Railways of 1825 as seen by Marc Seguin," and the other with "The First British Locomotives of the St. Etienne-Lyon Railway." Marc Seguin (1786–1875), nephew of Montgolfier, was one of the best-known engineers of the day, and papers and notebooks of his preserved at the family seat at Varagnes, near

Annonay, contain an interesting account of a visit he made to England in 1825, the year of the opening of the Stockton and Darlington Railway. Seguin met Brunel, Maudslay, Babbage, Stephenson, and Brewster, and travelled to Leeds, Newcastle, Edinburgh, and Liverpool. He himself was concerned at that time with a project for steam navigation on the Rhone, and the main object of his visit was to obtain engines. He saw, however, a good deal of the early mine railroads of England, while his account of the Stockton and Darlington railway is of great historical value. Sequin was connected with the St. Etienne-Lyon Railway and was an independent inventor of the tubular boiler.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant for technical records work at the Building Research Station of the Department of Scientific and Industrial Research—The Director, Building Research Station, Garston, near Watford, Herts (Mar. 21). A laboratory assistant at the Chemical Research Laboratory, Teddington—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1 (Mar. 21). A lecturer in the chemical and metallurgical department of the Wolverhampton and Staffordshire Technical College, and a lecturer in engineering subjects at the same institution—The Clerk to the Governors, North Street, Wolverhampton (Mar. 25). Lecturers in the spinning and weaving departments of Keighley Technical College—The Secretary, Education Offices, Keighley (Mar. 26). An assistant curator of the Leeds City Museum—The Town Clerk, 26 Great George Street, Leeds (Mar. 28). Professors of mathematics, and education and psychology at Raffles College, Singapore—The Secretary, Board of Education, Whitehall, S.W.1 (Mar. 28). An assistant in the department of archæology, Free Public Museums, Liverpool—Dr. J. J. Simpson, Free Public Museums, Liverpool (April 2). A woman professor of physiology at the Lady Hardinge Medical College, Delhi—The Honorary Secretary, U.K. Branch Dufferin Fund, c/o Major-General J. B. Smith, India Office, Whitehall, S.W.1 (April 19). A graduate for engineering subjects and mathematics at the Workington County Technical and Secondary School—The Principal.

Our Astronomical Column.

RETURN OF THE COMET PONS-WINNECKE.—This comet was detected by Prof. G. von Biesbroeck at Yerkes on Mar. $3^d\ 10^h\ 19{\cdot}5^m$ U.T., in R.A. $14^h\ 12^m\ 20{\cdot}4^s$, N. Decl. 25° 45′ 24″ (1927·0), magnitude 16·0. With the aid of this observation, and using the following elements, which are those of Mr. C. J. Merfield slightly modified, Dr. A. C. D. Crommelin has calculated the following ephemeris:

$$\begin{array}{l} T = 1927 \text{ June } 21{\cdot}1564 \text{ U.T.} \\ \left.\begin{array}{l} \omega = 170^\circ\ 22'\ 50'' \\ \Omega = 98\ \ \ 10\ \ \ \ 0 \\ i = 18\ \ \ 57\ \ \ \ 0 \end{array}\right\} 1927{\cdot}0 \\ \log q = 0{\cdot}016840 \\ e = 0{\cdot}685516 \\ \text{Period} = 6{\cdot}00983 \text{ years} \end{array}$$

EPHEMERIS FOR 0^h U.T.

	R.A.	N. Decl.	log r.	log Δ.
Mar. 13.	$14^h\ 23^m\ 23^s$	29° 5′		9·9410
17.	14 27 37	30 36	0·2106	9·9173
21.	14 31 34	32 11		9·8938
25.	14 35 23	33 49	0·1914	9·8703
29.	14 38 47	35 30		9·8467

T is 0·6 days later than Mr. Merfield's prediction.

The comet will make a very close approach to the earth in June, being at its nearest (3·6 million miles) about 0^h on June 27. Its parallax will then be 227″, and it will be well placed for observation, being on the meridian at 3^h A.M. in North Decl. 6°. Its daily motion will then be 11°·7, which is just equal to that of the moon in apogee. It should be readily visible to the naked eye, but may be rather difficult to observe for position in the telescope, as it will fill most of the field. The presence of a stellar nucleus is not very probable, but if there should be one, the occasion should be utilised for deducing the solar parallax.

THE FIREBALL OF FEB. 25.—Mr. W. F. Denning writes: "The observations of this brilliant object, though for the most part incomplete in scientific details, yet include some excellent descriptions and enable the real path to be determined with satisfactory accuracy. Seventy-four accounts were received, ranging from Leicester in the north of England, Sandwich on the east, Portland in the south, and Plymouth and Penzance on the south-east. That the object detonated rests on the testimony of about half of the observers.

"The radiant point was in Leo at 144° + 6° and the height of the meteor was 65 to 27 miles, path 54 miles, velocity 18 miles per second. These results are slightly different from those derived from the preliminary investigation.—The path was over Devon from about Kingsbridge to north of Dawlish. This shower from near o Leonis is visible from November until February. At any rate radiation is maintained from apparently the same point.

"The fireball was chiefly remarkable for the vividness of its intensely white light and for its double outburst. Many large meteors display very long paths from radiants near the horizon, but this object was comparatively near to its point of emanation."

THE ORBIT OF 61 CYGNI.—This double star has always excited great interest, since it was the first to have its parallax determined by Bessel. The duplicity was discovered by Bradley in 1753, and measures were obtained by Ch. Mayer, Sir W. Herschel, and later by Bessel. The latter ventured to assign the period of 460 years, but in the course of time it became clear that this period was considerably too short. Not a few astronomers (among them C. Flammarion and Burnham) questioned the orbital nature of the motion, and considered that it could be represented by a straight line. But Mr. T. Lewis, in his memoir on the Struve double stars, gave a large diagram which made the curvature palpable and obvious. P. Baize contributes an interesting article to *L'Astronomie* for January, into which he brings Mr. Lewis's diagram, with the addition of twenty more years of observations which have still further established the curvature. He makes a re-determination of the orbit, reaching results quite close to those given by Peters in 1883; the periods found are, Peters 783 years, Baize 756 years, so we may perhaps consider it as known within a century or so. Baize's other elements are: Periastron A.D. 1978, inclination 45°, eccentricity 0·013, semi-major axis 32″·8. Taking the parallax as 0″·28, the mean distance is 117 units, which would give a period of 1266 years if the joint mass was equal to that of the sun. The period 756 years, therefore, indicates a joint mass considerably in excess of that of the sun.

Research Items.

A Bronze Age Tumulus at Dunstable.—*Man* for February contains a report of the opening of one of the barrows (No. 5) of the "Five Knolls Tumuli" at Dunstable by the University College and Hospital Anthropological Society of London. This is the most northerly of the mounds. It is regular in shape, with a diameter of 50 ft. and a height of 5 ft. The remains of thirteen individuals were discovered. With one exception, those skeletons which showed no sign of disturbance were buried in the extended position with the head raised. The one exception was that of a female of Mediterranean type which lay in a crouched position in an oval cist cut into the chalk, the sole furniture being a flint knife. The skull showed a remarkable advanced symmetrical thinning. This feature is discussed by Prof. Elliot Smith in a note, in which he points out that this peculiarity is rare in Europe but common in the aristocracy of ancient Egypt from the third to the nineteenth dynasties. The only features common to the other skeletons from the barrow are presented by the limb bones. The cranial forms vary, though within narrow limits, being all mesaticephalic. In the lower limbs the femurs are all platymeric. Remains of two cremation burials were found, one accompanied by a cinerary urn of late bronze age type, which it may be assumed is of later date than the burial by inhumation near which it was found.

Rock Paintings from the Central Sahara.—Dr. P. Durand and M. L. Lavauden describe in Vol. 36, No. 5-6, of *L'Anthropologie* some hitherto unpublished rock paintings in the cave of In-Ezzan, Central Sahara, a little to the north of the Tropic of Cancer. This cave, situated in a circle of rocks from which issues a subterranean stream, is about 1700 kilometres south-east of the Straits of Gibraltar. It has been a halting-place for the nomads of the region from times immemorial. The paintings are executed in white and red, while certain missing details may once have been shown in a black which has now disappeared owing to the perishable nature of the charcoal or other form of black pigment used. The paintings are obviously of very different ages. The question of their date and affinities are discussed in an appended note by the Abbé Breuil, who classifies the pictures and inscriptions into ten categories. Of these the oldest are nude human figures, male and female, accompanied by tree or palmlike forms; one man carries a bow, and with him seem to be associated figures of oryx in white and red. A man clothed and bulls closely resemble figures of the Spanish paintings of Cogul. In another class are human forms, clothed, more schematic in design than the human figure last mentioned but with the same type of clothing, part of which is a kilt recalling the early Egyptian costume. These figures are accompanied by hounds of Asiatic type. Paintings in both white and red show Arab horsemen, hunting scenes, and a man mounted and armed with a long lance. The style, especially of the horses, suggests Sassanid art, and is evidently comparatively modern, as also are the inscriptions in Arabic. Apart from the groups which are evidently modern, the paintings present a great diversity of style and date, and morphologically recall now the art of the Bushman, now that of eastern Spain, and now that of predynastic Egypt.

Brewing in Babylon and Egypt.—The Society of History and Bibliography of Brewing of Berlin has recently published the results of the first of a series of investigations on beer and brewing by the peoples of ancient civilisations ("Bier und Bierbereitung bei den Völkern der Urzeit," 1. Babylonien und Agyptien. Berlin, 1926). The art of brewing has now been traced back to 7000 B.C., when brewing was a common household occupation of the peoples of the valleys of the Tigris and Euphrates. Dr. E. Huber shows that the beer of the day also played an important part in the social and religious life of this period. Definite rations of beer were allotted to each class of workman, and it was also used as an offering to the gods and as a diluent in medicine. The evidence in support of the cultivation and use in brewing at this time of Emmer wheat and of barley is of particular interest in view of the recent correspondence in Nature. By 5000 B.C. brewing businesses existed, often on a large scale. It is uncertain whether hops were used in Egyptian times, though there is evidence of the use of other flavouring herbs such as rue and safflower. The publication is profusely illustrated with photographs of Babylonian seal cylinders, chiefly of the time of Hamurabi, and of inscriptions and bas-reliefs from Egyptian tombs. A number of the latter are pieced together to form twenty-three scenes describing the complete brewing process. Dr. M. Phillipe contributes discussions of the brewing technique of these periods.

Scottish Sea Trout.—In a paper on the sea trout of the River Ailort and Loch Eilt (*Fisheries, Scotland, Salmon Fish.*, 1926, 3 (June 1, 1926)) Mr. G. H. Nall summarises the results deduced from figures and tables contained in an unpublished report. 1692 sets of scales, mostly between April and October 1925, were taken from fish varying in weight from a few ounces to 12 lb., and in age from 2¼ years to 12¼ years. Two fish, each of 12 lb., were in their thirteenth year, having both had 3 years of parr life, 2 years in the sea without spawning, and then spawned in seven successive winters. An interesting feature was the big run of heavy fish very early in the season in fat condition, with remarkably strong growth in the opening months of the year. An examination of the scales for 'slow growth' and 'rapid growth' zones indicated that these fish started rapid growth in December or January; growth ceased on entering fresh water, although the period of heavy feeding and rapid growth for the majority of fish was between spring and mid-August. There were indications that fish of the same smolt age tend to descend to salt water in company and remain together in homogeneous shoals during early sea life. Interesting comparisons are made between these sea trout and those from other districts in Scotland, which point to the fact that the farther north the district the longer the parr life and the later the approach of maturity. In the Ailort district, two-thirds of the smolts migrated after 3 years of river life, and there was a tendency for the older smolts after migration to mature earlier in life than the younger smolts.

Marine Biology in the Pacific.—In publications on "Marine Zoology of the Tropical Central Pacific" (Bernice P. Bishop Museum, Bulletin 26 and 27. *Tanager* Expedition Publications Nos. 1 and 2, 1925) results obtained on the *Tanager* Expedition of 1923–24 are given. This expedition was organised under the auspices of the U.S. Navy, the National Research Council, the U.S. Biological Survey, and the Bernice P. Bishop Museum. A survey was made of the thirteen islands of the Hawaiian group, extending north-east from Kauai to Ocean Island, and also of Johnston and Wake Islands. The work opens with an account by C. H. Edmondson of the Crustacea, in which 12 new species are described and figured and notes on distribution given, including a considerable number of new records for the North Pacific Ocean. W. K. Fisher deals with the sea stars, describing two new species and giving valuable information on the composition and distribution of the fauna. The remaining echinoderms are reported on by H. Lyman Clark. A short account of the polychætous annelids by A. L. Treadwell, with a description of two new species, is included; the specimens were, however, rather few owing to unsuitable methods of collection. This first publication concludes with a chapter by J. A. Cushman on the Foraminifera collected on the expedition. Photographic reproductions of some of the species described in the above articles are given. H. W. Fowler and J. C. Ball describe the fishes of Hawaii, Johnston Island, and Wake Island.

THE CILIATED CELLS OF THE GILL OF MYTILUS.—D. Bhatia has examined the structure of the latero-frontal cells of the gills of Mytilus (*Quar. Jour. Micr. Sci.*, vol. 70, Part 4, Dec. 1926). Between the corresponding cells of American species of Mya, Lampsilis, and Quadrula, Grave and Schmitt (1925) observed inter- and intra-cellular fibrils which they suggested represent paths for the conduction of stimuli from cell to cell and for co-ordination of the epithelium. Bhatia emphasises the importance of careful sectioning of the epithelium so as to display the whole extent of the cell and its intracellular fibrils. Each latero-frontal cell bears a pair of cilia which, as Carter showed, are loosely united. The exposed surface of the epithelium is covered with a continuous gelatinous cuticle with a wavy outline through which the cilia pass at the crests. Each cilium, which has a small microsome at its base where it enters the cytoplasm, *i.e.* immediately below the cuticle, divides into two rootlets, right and left (*r*, *l*, and *r′*, *l′*). The *r*, *r′* and *l*, *l′* rootlets gradually converge and near the nucleus fuse to form single fibrils which pass respectively right and left of the nucleus, unite in the base of the cell, and are firmly attached to the subepithelial layer. It is suggested that fibrils described by Grave and Schmitt as connecting adjacent pairs of microsomes are the inner edge of the cuticle. The author, while stating that his observations do not throw any new light on the function of the ciliary rootlets, thinks it is probable that the co-ordination of movement is effected by cell contact rather than by any specialised fibrillar mechanism.

FACTORS OF BIRD MIGRATION.—It has usually been assumed that either food or temperature, or a combination of both, released the migratory instinct; but a recent paper by Prof. William Rowan (" On Photoperiodism, Reproductive Periodicity, and the Annual Migrations of Birds and Certain Fishes," *Proceedings of the Boston Society of Natural History*, vol. 38, No. 6, pp. 147-189) points out that neither of these are of sufficiently regular recurrence to account for the extraordinary accuracy of arrival-date in a number of migrating species. The only environmental factor which would seem to fulfil the necessary conditions is length of daylight; and the bulk of the paper is devoted to a discussion of the possible influence of this. The author's case is of course strengthened by reference to the well-known and important discoveries concerning the influence of day-length upon plants, an influence first properly investigated by Garner and Allard in 1920. If such extraordinary effects upon rate of growth and time of flowering can be exerted by this agency in plants, there is every reason for suspecting that it may be operative in animals also. In birds it might operate directly, or indirectly through length of time available for feeding. In addition to a critical summary and discussion, Rowan refers to the results of his experimental investigations on the subject, of which a preliminary report appeared in NATURE (115, 494; 1925). He has definitely established that an increase of 'day' in autumn, produced by artificial illuminations after dark, will cause precocious growth of gonads (accompanied in the males by song) in the dead of a Canadian winter, in species which normally migrate southwards in early autumn. He has further established that control birds liberated in mid-winter when their gonads were at minimum size do not migrate southwards, while light-exposed birds whose gonads are beginning to enlarge, if liberated at the same time, disappear: one may, with the author, surmise that the light has so upset their normal endocrine equilibrium that they move northwards in spite of the arctic conditions. It therefore appears quite probable that relative length of day and light, acting via the gonads, determines the onset of migration.

LEAF STRUCTURES AND WOUND RESPONSE.—Although the healing of wounds in stems has provided a fruitful subject of investigation for numerous botanists, wound response in the leaf has so far received much less attention, and so it is of considerable interest to read the results of Prof. R. B. Wylie's experiments (*Science*, vol. 65, No. 473, Jan. 21, 1927). He considers that the thin structure of most leaves makes them well fitted morphologically for healing, on account of the comparatively small area of tissue exposed following lesion. Wounds made on leaves by removing circular areas with a punch are first of all closed up by a pseudocicatrice formed mainly from the collapsed thin-walled mesophyll cells damaged in punching. With the collapse of the interior cells, the upper and lower epidermal layers curve over and may even overlap, thus giving the wounded leaf a rounded edge. Certain secretions such as latex, gums, and resins may add efficiency to this preliminary barricade against water loss. One of the functions of the pseudocicatrice is considered by the author to be stimulation of the underlying tissues to the development of the cicatrice proper, which is formed by what corresponds to a phellogen layer developed by tangential divisions immediately behind the pseudocicatrice. Even the highly specialised epidermal layers respond by prompt mitosis, dividing by means of vertical walls only, a phenomenon one would scarcely expect in the very thick and heavily cutinised epidermal cells of sclerophyllous evergreen types. In brief, all cell layers of the leaf blade share in building up new protective tissue, and the cicatrice proper shows greater uniformity of cell size and content than the several cell elements which through mitosis have contributed to its formation. The cell walls in the cicatrice tissue are also usually modified chemically, and very early in its development the presence of lignin can be demonstrated behind the wounded margins. Wound healing may be complete in ten to twenty days, according to the particular species involved.

COMPASS VARIATION IN CANADA.—Bulletin 58 of the Topographical Survey of Canada (price 10 cents) is entitled "The March of the Compass in Canada, and Daily Variation Tables." The author, W. H. Herbert, gives a very interesting and well-written account of the secular change and daily variation of the compass declination, and their importance for all who make use of the compass in practical life. For nearly all the early land surveys in Canada the boundaries were defined in the deeds by compass bearings, and in order to re-trace and re-establish these old boundaries, and to link together old surveys, it is desirable to have trustworthy and accessible information as to the past and present secular variation of declination throughout Canada. The Bulletin, therefore, which is prepared primarily for compass users, gives tables of the declination at 126 well-distributed stations for every tenth year from 1750 onwards (when data are available) to 1900, and thereafter for every fifth year to 1925. At many of the stations the earliest data are for 1820 or 1880. These tables thus indicate the secular variation at the corresponding stations and the regions around them. Tables of the average diurnal variation of declination, which must be taken into account in accurate surveying by compass, are also given for 24 stations for the summer, winter, and equinoctial seasons. Detailed examples of the use of the tables are given. The Bulletin should interest and help all who, for duty or pleasure, have occasion to travel off the beaten track in Canada.

GOLD COAST SURVEY.—The Report of the Survey Department of the Gold Coast for the year 1925–26 shows a record of continued progress in actual field work, in the training of surveyors and draughtsmen and the publication of further sheets of the topographical map. The surveys are now completed of the whole of the Gold Coast Colony, the greater part of Ashanti, and the eastern part of the Northern Territories. During the present year work is on hand in the Northern Territories, the western frontier of Ashanti, and the mandated territory of Togoland. It is of interest to note that the map sheets are now all printed in Accra instead of in Britain. The report includes a layer-coloured map of the southern part of the Gold Coast on a scale of 1 to 500,000, which shows the excellence of the local colour printing and technique.

HEATS OF ADSORPTION ON CHARCOAL.—The heats of adsorption of oxygen, chlorine, carbon dioxide, ammonia, ether, chloropicrin, and water on charcoal at 0° have been measured by F. G. Keyes and M. J. Marshall. The ice calorimeter was employed, and the charcoal was contained in an evacuated quartz tube. In every case a large initial adsorption was noticed, which rapidly fell to a constant value with increasing concentration. Interesting conclusions are drawn from the detailed results, which appear in the *Journal of the American Chemical Society* for January 1927. The adsorbed vapour is considered to be in a special state, and only the first layer is directly influenced by the adsorbent. Because of this special state, the first layers form new adsorbing surfaces which adsorb molecules of the same kind. This special state becomes less pronounced with each succeeding layer, and finally a layer is reached in which the molecular arrangement corresponds to ordinary contact.

PROPAGATION OF SOUND IN WIDE PIPES.—In the December number of the *Annales de Physique*, M. Th. Vautier describes a repetition of Regnault's classical researches on the propagation of sound in wide pipes. The pipe chosen for these experiments was a conduit intended for water. It was one metre in diameter, made of cast iron, and placed under the pavement of the Cours Gambetta, Lyons. A section of this conduit, of length 1640 metres, was available for the experiments. The ends of the section were closed with wooden planks, and a gap at one end of the section allowed the insertion of recording instruments. The latter consisted either of rubber membranes or suspended mirrors or microphones, which, owing to their inertia, could only be used to register the passage of the waves and not their form. Records of the form of the waves are promised in a later memoir dealing with records obtained by an interferometer method. The source of the sound impulse was a pistol or a powerful spark from an electrostatic machine. Vautier gives numerous oscillograms which indicate the response of the recording apparatus. Reduced to dry air at 0° C., the velocity of sound found in these experiments was 330·54±0·5 metres per second. The value obtained by Regnault with a conduit 1·1 metre in diameter was 330·45 metres per second. The value obtained by Esclangon as the mean of a large number of experiments in the open air carried out during the War, was 330·9 metres per second.

CARBON ASSIMILATION.—In *Scientia*, vol. 41, Feb. 1927, Prof. Walter Stiles gives a lucid and closely reasoned review of the present state of our knowledge and conceptions of the mechanism of carbon assimilation in plants. He considers the conclusions regarding the process of photosynthesis arrived at by various chemical investigators invalid, on the ground that they are based on experiments conducted *in vitro*, and form no criterion of the actual processes going on in the plant amid the complex of physiological factors found in the actual protoplasm itself. So long ago as 1861, Butlerow was able to produce a sugar-containing substance from a derivative of formaldehyde, and there seems no doubt that formaldehyde can be produced from carbon dioxide and water, and sugar from formaldehyde, without the aid of the living green plant, but this constitutes no evidence that the course of synthesis *in vivo* follows on the same lines. Even the theory of Willstätter and Stoll, based on physiological work with living plant material, assumes the formation of formaldehyde as an intermediate product in photosynthesis, though the evidence for the presence of that substance in plants is of a very slim kind. Some considerations are adduced for concluding that the complete photosynthetic process must comprise both a photochemical stage and a 'dark' chemical stage in which light is not involved. Willstätter and Stoll thought the chemical stage was controlled by some enzymatic factor, and there is considerable evidence supporting this hypothesis. The problem of changing radiant energy to chemical energy in the assimilating cell is closely bound up with the function of the four leaf pigments, chlorophyll-*a*, chlorophyll-*b*, carotin, and xanthophyll, but no completely convincing explanation of the rôles of all four pigments has yet been given. While a satisfactory understanding of the mechanism of carbon assimilation is so far nonexistent, knowledge on the subject is becoming fuller and clearer, but a complete solution of the problem will require the co-operation of workers in the three fields of botany, chemistry, and physics.

ULTRA-VIOLET THERAPY APPARATUS.—Messrs. Watson and Sons (Electro-medical), Ltd., have issued a new edition of their booklet on "Artificial Sunlight" as Bulletin No. 80. The first 10 pages are devoted to a brief account of the nature of ultra-violet rays, their method of production, and their properties; the remaining 36 pages contain a detailed account of the various sources of artificial sunlight now available. The illustrations are very good, and show how quickly the various medical needs of a technical character are being met by manufacturers. There is scarcely a part of the body for which some special piece of apparatus has not been designed, for the administration of ultra-violet rays to it. The booklet includes also an account of devices for the measurement of the rays when used clinically. There is no unanimity yet as to the best method to be adopted for this purpose, but in the meantime medical men will be glad to know of the selection that does exist.

Science in Japan.

By Prof. C. COLERIDGE FARR, Christchurch College, Canterbury, N.Z.

AS a delegate from the New Zealand Institute I had the honour and great pleasure to visit Japan on the occasion of the third Pan-Pacific Scientific Congress which was held there in October and November last, and an account of that visit may be of interest. As a physicist, and from a scientific point of view, I confined my attention solely to physics, geophysics, and cognate branches of knowledge; and I must leave other delegates to make such remarks as they may think necessary on the branches of science which interested them. Before dealing with the main subject of this article, however, I desire to make several observations of a general character.

ORGANISATION.—The organisation of the meeting was remarkable for its completeness and thoroughness, and is a great credit to those who had to do with its development. On entering Japanese waters at Nagasaki, a port at least 850 miles from the city of Tokyo, where the meeting was held, we were met by an emissary from the Conference, Dr. Oshima, and from then until the moment of sailing again from the same port four weeks later, we were not without the assistance of honorary guides, who were Japanese gentlemen who could speak English fluently. I believe similar guides met every party arriving from oversea at their port of arrival, and that each party was also 'shepherded' in the same way as we were throughout the tour. The amount of strenuous effort on the part of the guides must have been tremendous. They took control of all the baggage—and I did not hear of a single instance of loss—they made all the necessary arrangements regarding sleeping berths in the trains, they provided meals where the travelling was done in trains which had no dining-car—in fact they saw to all details, and seemed to leave nothing whatever to chance. The benefit of this in a land with a foreign and absolutely unknown language cannot be imagined, and only became apparent to us on those occasions when—breaking away from our guides—we attempted to make our own way about in some of the cities. Progress then, if not impossible, became exceedingly slow. The people one met were courtesy itself but could not understand what we wanted, nor could we understand their answers, and it was therefore necessary to light at length upon some person who did understand something of the language one was speaking.

In all other respects the organisation of the meeting was at an equally high level.

JAPANESE COURTESY.—Perhaps it may not be out of place to make a few observations upon this delightful feature of Japanese life which impressed itself upon so many of us upon numerous occasions. The Japanese seem—as was stated by a speaker at one of the functions that were held—to be a nation of gentlemen. They appear to be as courteous amongst themselves as they certainly were to us. One could notice the most polite meetings and partings of Japanese who did not know they were being observed. The school children that one met—and they were everywhere to be seen—were friendly and orderly amongst themselves, and prettily responsive to greetings from us. I heard of no unpleasant incident, but I myself had many examples of courtesy which would be exceptional in some other parts of the world. Not once or twice, but many times, have I asked my way to a place from a person who understood what I wanted but whose answer I was unable to comprehend. On every such occasion he would answer, "I will show you," and would go perhaps half a mile out of his way to do so. Or if a *rikisha* or motor-car was available he would call it and give directions to the man. Courtesy seems to be a natural and very pleasant trait in Japanese character.

SCIENTIFIC ASPECTS OF THE MEETING.—If the Congress left anything at all to be desired it was more time for the reading and discussion of papers. In all, some four hundred papers were sent in, which had to be got through in ten days. This necessitated very strict time limits being imposed upon authors and speakers, and it was a very exceptional paper that could be given more than ten minutes. Though no doubt it would be well to have more time, yet such restriction is not so bad as it might seem. Fairly complete abstracts were available, and were often read in place of the paper. These abstracts were printed and distributed on the morning or afternoon that any particular paper came on, and it could thus be seen in advance what the paper was about, and as all the delegates were staying at the same hotel in Tokyo, there were many other opportunities for discussion. It was in the hotel that some of the most valuable discussions took place, between perhaps the author of a paper and others who were interested. It is often the case in scientific meetings such as this, that informal discussions arising out of papers read are more productive of good than the actual hearing of the papers. To appreciate fully the work described by an author in a written paper, it is necessary to read and study the paper, and in physical and mathematical papers it is frequently important to work out anew the author's mathematical reasoning. For this the publication of the paper is essential, and in the present case most, if not all, of the papers read will in due course be published. Thus although the number of papers offered was very large for the time available, yet I think all the delegates felt that this did not militate against the success of the meeting to the extent which it might have been expected to have done by those who were not present. In future meetings it may perhaps be well if a previous censorship of papers is instituted, so that only those of outstanding importance shall be read.

CONSTITUTION OF THE CONGRESS.—Until the present meeting, I believe the meetings of the congress have been conducted without any very definite constitution or by-laws, much being left to the president, and to the discretion of those organising the next forthcoming meeting—that is to say, to the local organising committee at the place of meeting. At the Tokyo meeting, however, a definite constitution and by-laws were drawn up and received the approval of the conference as a whole. By this constitution the name of the conference is now "The Pacific Science Association," and its meetings are to be held at intervals of not less than two or more than five years. The constitution consists of fifteen clauses, of which Clause 4, relating to the constitution of the Council, is probably the most interesting and important from the point of view of the New Zealand Institute. The administrative work of the association is arranged to be carried on by a council of not more than fifteen members, the seats being allotted to 'Countries' of which eleven or twelve are named in the constitution, leaving three or four vacancies for countries that may at some future time desire to come in. The countries so far named are the United States of America, Canada, Australia, France, Great Britain, Hawaii, Japan, Netherlands, Netherlands East Indies, New Zealand, Philippine Islands, and Russia, and these countries are to be represented on the council each by one member, who is to be elected by its National Research Council, or by some other scientific organisation of recognised standing. The scientific bodies thus having electoral powers are named in the constitution, and in the absence at present of a National Research Council, the New Zealand Institute has been named for New Zealand.

Amongst the by-laws, which consist of fourteen articles, there is one (Art. 7) for which perhaps we may be grateful. It provides that the usual language of the congress shall be English.

Visits to Scientific Institutions.—This journey to Japan presented exceptional opportunities for visiting and obtaining information about the activities of any particular scientific institution there in the work of which one might be interested. In most cases visits of a large body of delegates to these institutions was a part of the programme of the Congress, but at such visits the greatness of the numbers present prevented many questions being asked, or much individual attention being given to any particular visitor. They were, however, most valuable, as they showed all who took part in them how much Japan is doing in the cause of science. One had, moreover, only to express a wish to see any particular institution and a more or less private inspection of it was most willingly and most courteously arranged. In this more complete way I was enabled to see some most interesting organisations, the work of some of which will now be referred to.

Aeronautical Research Institute, Tokyo.—This institute is, and always has been, a part of the Imperial University of Tokyo. The first of the ordinances which govern it states that the Aeronautical Research Institute shall be attached to the Tokyo Imperial University, though its present location is some miles from what is actually the Imperial University building. It concerns itself with the investigation of all subjects relating to aeronautics, a term which it wisely interprets in a very broad manner. It is a development of the Investigation Committee on Aeronautics which was founded under the chairmanship of Dr. A. Tanakadate in 1916. The Research Institute dates from 1918, and, like most other Tokyo institutions, was very seriously damaged by the 1923 earthquake. It is, however, rebuilt sufficiently to enable work to be carried on there pending the completion of a much larger and more complete institution at another part of the city. Much might be said about this institution, but here only a few of the points which were most interesting to myself can be referred to. The work of the institute is divided into twelve departments, which are as follows: Physics, chemistry, metallurgy, materials, wind tunnel, aero engines, aircraft, instruments, aeronautical psychology, central library, workshop, and office.

It will be seen that at the head of this list of departments, which is taken as it stands out of a report of the Institute, the fundamental sciences of physics and chemistry are recognised as of the first importance to progress. This is the case in all the Japanese research establishments of this nature, and there are very many of them. Without progress in the fundamental sciences, progress in the applications is impossible. The whole institution is under the general control of Baron Shiba. The liberal staffing of the various departments is worthy of more than passing notice. Thus the physical department has five chief investigators, nine senior assistants, seven junior assistants, and two laboratory attendants. The chemical department has seven chief members, one senior assistant, five junior assistants, and one laboratory attendant. The aero-engine department has eight chief investigators, twelve senior assistants, fifteen junior assistants, and twenty-two laboratory attendants, and so on throughout the whole of the Institute. The subjects under investigation at present are some nineteen in number in the physical department, nine in chemistry, five in metallurgy, two in materials, seven in the wind-tunnel department, thirty-three in the aero-engine department, eleven in the aircraft department, five in the instrument department, and seven in the aeronautical psychology department, making in all about a hundred different subjects which are under investigation in this one Institute of Aeronautical Research alone. Many researches have been completed and have led to results of great value, and one finds amongst these such subjects as the transverse vibrations of elliptic and rectangular plates, the content of helium and other constituents in the natural gases occurring in Japan, and many others. The bearing of the first of the subjects mentioned is of course in connexion with the vibrations of aeroplane wings, and that of the second with the inflation of dirigible balloons. One must visit Japan to realise what is being done in institutions like this; institutions, that is to say, the whole object of which is research.

It is here and at similar places that every advance in scientific method is examined, and if possible some application of it is made to the practical problems under consideration. The remotely, or seemingly remotely, connected subject of piezo electricity finds a most valuable use in the investigation of the pressure of piston rings and the wearing of cylinder walls. Electric valves find an application here to the examination of the rate of dissemination of the gaseous charge to different parts of the cylinder, and it may be that some alteration in the design of the form of the cylinder from the old cylindrical shape to some other in which the charge is spread more quickly and more uniformly throughout it may result from this work. Very much more could be said about this interesting establishment at which, owing to the courtesy of Baron Shiba, I was able to spend an all too short morning, but it is, after all, only one of many other similar places, and I must refer to some of the others.

The Institute of Physical and Chemical Research.—Perhaps the best way to begin my remarks upon this will be to quote from a pamphlet which was published this year concerning it: "The Institute conducts investigations in the pure sciences of physics and chemistry, aiming at their industrial development, and at the same time engaging in applied research. No undertaking, whether it be in industry or agriculture, would be able to attain sound development unless it was based on physics and chemistry. Particularly in such a densely populated country as Japan, where industrial materials as well as other commodities are not ample, it is essential to aim at the development of industry by having recourse to science, thereby promoting national interests. The object of the institute is to perform this important mission.

"When any physico-chemical applied research is completed in the laboratory it is tested for its industrial applicability, and in case the test shows an appropriate result, arrangement for manufacture is carried out at the Institute; or the manufacture may be entrusted to others; or a new company may be established on the basis of a remunerative contract with the Institute, depending upon the nature of the work. At present there are several undertakings that have already existed as industries or are going to exist as such. As the fundamental cause of success in these applied researches lies in there being sound scientific investigations at the back of them, a part of any profit accruing to the Institute is allotted to the investigation expense of pure science and a further part is given as a reward to the inventor or discoverer."

The staff of this institute numbers 384, of whom 216 are directly engaged in the investigations; the number of distinct lines of research pursued is, this year, 171, whilst last year it was 154. The results of the researches are published, very often in the English language, but they do not appear, as a rule, in any of the more generally recognised scientific journals which we see, at any rate in New Zealand.

Glancing through a list of the investigations, one would scarcely realise that this Institute of Physical and Chemical Research is, like the Aeronautical Research Institute, utilitarian in its work. But the Japanese have realised that for the industries to attain a sound development it is an absolute essential that they should be based upon the fundamental sciences of physics and chemistry, and that any advance in these means a hundredfold corresponding advance in the industries and in agriculture. They therefore interpret the charter in the broadest possible spirit, and amongst the 171 distinct investigations in progress in the Institute there are to be found those relating (*a*) to the transmutation of mercury into gold; (*b*) the calculation of mutual and self inductance; (*c*) photo elasticity; (*d*) the manufacture of synthetic *sake*; (*e*) the by-products derivable from waste human hair, and 166 others. The greatest freedom is given to the investigators in their work; they are free to undertake or reject any proposed problem. They are experts in their work, and are treated as such, but they receive some benefit of a financial kind for any practical applications of their work. I had the benefit of spending an afternoon at this most interesting institution, and was most kindly shown round by Prof. Nagaoka, whose scientific reputation is very well known, and by Viscount Okochi, who is the superintendent and director of it.

The time available was of course much too short to appreciate all or nearly all that was going on, and very little of the work could really be seen; but what I did see showed how complete and efficient the methods of investigation were, and what a valuable stream of knowledge is issuing from it.

The Institute was founded only nine years ago and its income is derived from an endowment of more than £600,000, about one-sixth of which was an Imperial gift, a third was a government subsidy, and the other half consisted of contributions from official sources as well as from individuals. The income is now no doubt being augmented by its interest in the rights of some 140 patents which have been obtained as the result of investigations carried out at the establishment.

The Research Institute for Iron, Steel, and other Metals at Sendai.—It is a remarkable thing, and one to be noticed, that many of the 'practical' research institutions of Japan are connected with universities. The Iron and Steel Institute is a part of the Imperial University at Sendai, and the Aeronautical Institute is part of the Imperial University of Tokyo, whilst the Institute of Physical and Chemical Research is closely connected with the Imperial University at Tohoku. This fact becomes more and more impressive the more of these institutions one is able to obtain information about. The Iron and Steel Institute began in a somewhat small way in 1915 to deal with problems arising out of the War, but its scope has been rapidly enlarged, until in 1924 its staff was seemingly about 54 persons, namely, 22 experts and 32 assistants, with Prof. Honda, a man whose reputation has been recognised in Europe for many years, at their head. The research staff consists of twenty members, all of them men of distinction and learning.

Forty-one problems have been the subjects of investigation since September of last year, of which a few may be enumerated, though these are picked at random from the list: (*a*) The viscosity of molten metals and alloys; (*b*) comparative investigation of hardness testers; (*c*) investigation of magnetic sands; (*d*) the effect of sulphur on iron and steel. The Institute publishes its results—or at least some of them—in the *Science Reports* of the Tohoku Imperial University, in European languages, and has thus published in some accessible European language no less than 140 papers. The knowledge contained in these papers must be a very mine of information for those engaged in metallurgical questions, and it speaks most eloquently for the broadness of the view that the Japanese adopt, that they have published these papers in a European language, as indeed they do most of their papers in every institution. In the vast majority of cases the language used in recent years is English.

The regulations with regard to patent rights arising from work done in the Institute are well worthy of study, especially as similar questions will crop up in connexion with the Department of Industrial Research which is about to be established in New Zealand.

The Geophysical Laboratory at Beppu.—This laboratory, which is a part of the Imperial University of Kyoto—though it is several hundred miles from it—has only been established recently. So far, no publications have issued from it, though a good deal of work is in hand. The laboratory is situated in one of the principal hot-spring regions of Japan. The work undertaken there consists of researches into changes of level, temperature, hydrogen and chlorine ion content, and electrical conductivity of the hot-spring waters. Micro-seismographs magnifying fifty thousand times are to be seen there, and the institution is undoubtedly being established at Beppu on a very broad and valuable basis. Indeed, it might form a better model upon which to establish our own proposed vulcanological station than the Hawaiian Vulcanological Observatory. The latter is, perhaps, more concerned with activities of a living volcano, whereas this Geophysical Laboratory is in a region not very unlike Rotorua, although perhaps of rather less activity than Rotorua. Dr. Shida, of the Geophysical Department of the Kyoto University, is in charge of the laboratory, and many of the instruments in use in it are of his own design.

Research in Japan.—What I have said refers to the institutions that I was able—in the exceedingly short time available—to visit. I am afraid it gives a most imperfect idea of the work that is going on in them, and it certainly gives no idea of the amount of research in progress in Japan. Besides the work at institutions solely intended for research purposes—and to deal at all with these would need a volume rather than a short report—besides these an immense amount of first-class research work is done at the universities themselves. There are forty-five government or municipal research institutions in Japan. As well as these, there are twenty-five other institutions either privately endowed or maintained by business firms (one of these is the Institute of Physical and Chemical Research already referred to), and this number does not include observatories, of which there are many. The average number of research 'experts' employed in these institutions is about twenty, which number does not include those who are classed as 'assistants' and are very much more numerous, probably at least double as many.

The Imperial Universities.—There are six of these, namely, Tokyo, Kyoto, Tohoku (at Sendai), Kyushu at Fukuoka, Hokkaido, and Keijo. There are also other universities, known as private universities. The staffing of these universities is to a New Zealander exceedingly liberal, but it accounts for much that it would be otherwise impossible to explain. The Tokyo University, besides teaching its students, or rather perhaps as an aid to teaching its students, maintains the following institutions: (*a*) The Tokyo Astronomical Observatory; (*b*) the Earthquake Research Institute; (*c*) the Aeronautical Research Institute; (*d*) the Institute for Infectious Diseases; (*e*) the Seismological Institute; (*f*) the Botanic Garden; (*g*) the Marine Biological Station; as well (evidently) as some others.

The Kyoto University has associated with it: (*a*) The Astronomical Observatory; (*b*) the Kamigamo Seismological Station; (*c*) the Beppu Geophysical Laboratory; (*d*) the Seto Marine Station; and (*e*) the Otsu Hydro-Biological Station. These are, of course, in addition to the usual laboratories which are to be found in every modern university.

The general policy and mode of working of these universities can perhaps be seen from considering one department in one of them, and the one I naturally choose is that of physics at Kyoto. The Department of Physics is divided into three sub-departments, namely, (*a*) physics; (*b*) cosmical physics; and (*c*) geophysics. The sub-branch physics has in it four professors, three assistant professors, and two lecturers, and I was informed that there are less than 60 students taking the subject. The sub-branch cosmical physics has two professors and two lecturers. The sub-branch geophysics has three professors, two assistant professors, and nine lecturers. The liberal scale of staffing is thus apparent, and amounts in the sub-branch physics to less than seven students per teacher. The students enter the University at the average age of about twenty-two years. Such a system produces first-class men, and, moreover, so restricts the field of study of the professor or teacher that he is enabled to be really an expert in his branch, rather than a man who perhaps knows something of many branches and knows none of them well.

The cost is of course proportionally high, but that Japan finds that it pays is shown by the figures relating to the Kyoto University, which are taken from the Kyoto University Calendar for 1926. The University is a very modern institution, only boasting twenty-nine years of existence—it was founded in 1897. The cost of it during that year was approximately £5400, whereas during the year 1926 it was £500,000. As there are something a little under 4000 students at the University (in all grades), this cost is about £125 per student per annum at present. In the whole Department of Science in the University of Kyoto there are 85 teachers. To cover the same work in Canterbury College we have about ten teachers. The number of students in this Department in Kyoto is 250, which is probably about what it is in Canterbury College—indeed, it may be more at the latter place.

The same kind of thing holds in every department of all the six Imperial universities of Japan. Japan has realised that the thorough education—specialist education, of course, in every case—of a comparatively few is more the function of the university, and pays the nation better than the cheap sort of education of a great many. Perhaps I may quote from an Imperial ordinance governing universities which was promulgated in 1918. Art. 1 of that ordinance gives a concise statement of the functions of a university as conceived in Japan. It reads: "Universities shall have for their objects the teaching of such sciences, theoretical and practical, as are required for the purposes of the State, and the prosecution of original research in the said sciences; and consideration shall be given to refinement of character with an eye to fostering national ideas." A narrow view of the word "sciences" as used above is not taken, and Art. 2 specifies the departments which may be set up, of which "Literature" is one.

It is no doubt in the spirit of this ordinance that the universities of Japan are such centres of research. They have realised, as some one once put it, that "the function of a university is not to teach," but that it also has the further function of learning as well, and that by learning, teaching is best done. These universities have therefore established such places as the Aeronautical Research Institute and the Beppu Geophysical Laboratory, to which reference has already been made, as well as many other institutions of an analogous sort, and it is to these that the students are drafted as they become more proficient in their work, and they see the work done there as it is done in actual practice, and they advance knowledge at the same time.

In conclusion, I may perhaps refer to an opinion which was expressed to me by one of the Overseas delegates having special knowledge of the interaction of science and industry. He told me that he thought that the organisation of the co-operation of the two is more complete in Japan than in any other of the many countries he has visited (which included England, France, the United States, Czechoslovakia, and Germany), with the exception of one of them, which, so far as I remember, is Germany. Thus the work started in the 'seventies by Ewing and Ayrton and Perry has borne rich fruit for this progressive Empire.

The Diffusion of Culture.

The Frazer Lecture was delivered at Cambridge by Dr. R. R. Marett, reader in social anthropology in the University of Oxford, on Mar. 2. Dr. Marett, taking "The Diffusion of Culture" as his subject, dealt chiefly with the views of Prof. Elliot Smith, whether as expressed positively or as implied in the criticism of rival doctrines. Thus as a critic he stigmatised Tylor's animism as mere guess-work which defies the known facts. Again, he regards "The Golden Bough," however learned, as based on a fallacy and as amounting to nonsense because it does not follow the historical method. The reply to these criticisms seems to be that the whole virtue of scientific method consists in being "sufficient unto the day." To require that what may be proved now might just as well have been proved fifty years ago is to ignore the historical conditions that determine movement of thought. In view of the immense stimulus given to research, no less in the field than in the study, by the working hypotheses carefully formulated as such by Tylor and Frazer, it is absurd to accuse them of having laboured in vain. In short, the critic seems to be deficient in that historic sense which he desiderates in others.

Turning from the polemics to the positive tenets of the diffusionist school, Dr. Marett distinguished between the special question of whether Egypt could be shown to be the sole originator of civilisation and the general question whether a diffusionist method is capable of taking entire charge of cultural anthropology. The evidence for and against the claims of Egypt as the cradle-land of civilisation being too vast to consider briefly, Dr. Marett was content to examine a single specimen of the proofs on which Prof. Elliot Smith relies, namely, his contention that the earliest conception of a deity arose out of certain beliefs connecting the cowry shell with the female principle. Here 'earliest' can scarcely mean more than 'earliest known,' in view of the notorious imperfection of the historical record. Even so, it is possible to cite from palæolithic Europe only, a variety of practices of seemingly ceremonial intention suggesting that the idea of deity may have had many other sources than the one alleged. What Prof. Elliot Smith puts forward with assurance is thus at best a more or less plausible hypothesis which needs to be framed with all due reservations and precautions.

As to the all-sufficing efficacy of the diffusionist method, there is uncertainty at this point within the diffusionist school itself, seeing that Dr. Rivers was for assigning the last word in cultural anthropology to psychology, though only after the study of cultural diffusion had been more fully developed. But surely there is a present need of psychological analysis as applied to primitive culture as we meet with it under existing conditions. Diffusionism offers us merely an exterior history of culture, a number of particular events following one on the other without apparent rhyme or reason. Psychology alone can supply the general law or tendency that brings the particular facts into relation. It alone, therefore, can furnish the hypothetical bridge that leads to the discovery of fresh particulars of the same kind by enabling their real character to be recognised. Prof. Elliot Smith can be shown constantly to assume psychological principles in his account of the diffusion of culture; but since he is unconscious of so doing, his psychology is uncritical and, therefore, crude.

Stated temperately and with a due sense of the difficulties, Dr. Marett is of opinion that Prof. Elliot Smith's theory of Egyptian influence deserves the most careful attention, but the present dogmatic assertions of the diffusionist school are out of place.

University and Educational Intelligence.

CAMBRIDGE.—Prof. J. A. Fleming, Prof. G. F. Stout, and Prof. A. E. H. Love have been elected honorary fellows of St. John's College.

Mr. A. Amos, Downing College, has been reappointed director of the University farm for five years. Various fresh lectureships in mathematics, agriculture, physics, engineering, and economics will be established. Some of these represent steps in completion of the changes from the old conditions to the present ones under the new Statutes.

The report of the Faculty Board of Archæology and Anthropology mentions considerable additions of interest to the collections in the Museum of Ethnology. These include a number of objects of the dolmen age from Portugal and Brittany, presented by Mr. L. C. G. Clarke, English pygmy implements from the Pennine region presented by Mr. F. Buckley, Baron von Hügel's Tongan collection, a magnificent Hindu Indian totem-pole, 45 feet high, and a Kwakintl Indian house-pole in the form of a grizzly bear, presented by Dr. Glaisher, and various bequests already mentioned in these columns.

LONDON.—The title of reader in geometry in the University has been conferred on Mr. J. L. S. Hatton in respect of the post he holds at East London College. Mr. Hatton studied at Hertford College, Oxford, and for two years was demonstrator at the Clarendon Laboratory, Oxford. Since 1896 he has been Principal of East London College and head of the Mathematical Department.

PROF. D. A. GILCHRIST, professor of agriculture at Armstrong College (University of Durham), Newcastle-on-Tyne, and Director of the Northumberland Agricultural Experiment Station at Cockle Park, having reached the age-limit, has resigned. Prof. Gilchrist is best known for his Cockle Park experiments on the use of phosphatic manures and wild white clover for grassland.

THE annual general meeting of the Association of Technical Institutions was held in the Goldsmiths' Hall, London, on Feb. 25-26. The incoming president, Lord Riddell, chose as the subject for a racy address "The Business Climate." He believed that the causes of good and bad trade are just as capable of scientific discovery as are the causes of climatic change; and, in the case of trade, he regarded education and organisation as the means of coming nearer to a state of affairs less charged with uncertainty and error. An important section of the Association's annual report showed that in most institutions there is available a very limited number of books of a technical nature, and, in some cases, what there are appear to be out of date and of no real value. Some six schools reported a provision of £200 per annum for additions and renewals, but in the great majority of institutions the average expenditure is £20-£30 per annum. In order to direct attention to such serious defects in the distribution of technical literature an analysis of questionnaire results was sent to the Association of Special Libraries and Information Bureaux which promoted the reading of a paper dealing with the matter at a recent meeting at Oxford. "The Technical Training of Students for the Worsted and Woollen Industry" (by Prof. E. Midgley); "The Value and Functions of Advisory Committees in Technical Education" (by Mr. G. F. O'Riordan); "The Technical Training of Students for the Cotton Trade" (by Mr. W. Wilkinson): these titles of some of the papers read during the conference will indicate the subjects round which valuable discussion centred. A paper by Mr. J. R. Riddell described excellent work in connexion with training for the printing industry, but was somewhat marred by a singularly imperfect conception of the complementary nature of the contributions to be made to education by industrialists and "well-intending but theoretical educationalists."

IN view of the growing importance of technical education, a paper by Principal J. F. S. Ross, read at the recent meeting of the Association of Technical Institutions, was especially valuable. Dealing with "Some Problems of the Smaller (Technical) Institution," he directed attention to the problem of an institution which has to be staffed by visiting teachers. The method certainly has the advantage of securing specialists who, during the day, are engaged in the trade or profession for which, in the evening, they prepare their students. There are, however, many disadvantages: efficiency and the corporate life of the school are handicapped not because the visiting teacher lacks quality, but because his work is restricted and limited by the essential conditions of his appointment. As part of the solution of the difficulty, Mr. Ross considered that every department of a technical institution which promotes a full-time senior grouped course covering three years should have at least one full-time teacher. The chief obstacle to such an arrangement lies in the present superannuation regulations; but Mr. Ross's paper showed clearly not only the equity of an alteration of these regulations, but also the enhancement of the value of technical education which would result.

Calendar of Discovery and Invention.

March 13, 1759.—In 1757, Clairaut began his long calculations on Halley's Comet, in which he was afterwards assisted by Lalande. In Nov. 1758 he announced that the comet would reach perihelion on Apr. 13, 1759, though its arrival might differ from this date by so much as a month. The comet reached perihelion on Mar. 13, 1759, the accuracy of Clairaut's prediction being regarded as a brilliant triumph of Newton's theory.

March 13, 1781.—Herschel's great review of the heavens began in 1775 and was carried out mainly with telescopes constructed by himself. On Mar. 13, 1781, while examining some small stars, he discovered what he thought was a comet. Further observations and calculations by himself and others, however, proved the newly discovered body to be a planet to which the name Uranus was given by Bode.

March 14, 1794.—Cotton has been cultivated from the dawn of history. It is mentioned in the Rig Veda hymn, composed fifteen centuries before the Christian era, and the roller gin for cleaning cotton was evolved in India 300 B.C. Roller gins, however, are not suitable for cleaning the 'upland' cotton grown in America, where all cotton was cleaned by hand until the invention of Whitney's gin, patented on Mar. 14, 1794. In 1791, 189,500 pounds of cotton had been exported from the United States; nine years after Whitney's invention the amount exported had grown to 41,000,000 pounds.

March 15, 1816.—The national standard of length in Great Britain up to 1824 was the yard of Elizabeth, kept at the Exchequer, which, said Baily, was such that "a common kitchen poker filed at the ends by the most bungling workman would make as good a standard." Through a resolution of the House of Commons on Mar. 15, 1816, the Royal Society initiated experiments to find the length of a pendulum swinging seconds, one of the objects being to compare British and French standards, and these were the beginning of experiments spread over many years which gave us our present standards.

March 17, 1876.—Kelvin, writing to Andrews of Belfast on Mar. 17, 1876, said: "I have to-day been seeing an exquisite electrical experiment, quite a first-class discovery by Dr. John Kerr." What the discovery was Kerr explained to the British Association that year when he showed that when polarised light is reflected from the end of the core of an electro-magnet, the plane of polarisation is rotated under the influence of the magnet in a direction opposite to the conventional direction of the current. These experiments led to the fundamental researches on electro-optics and magneto-optics of later physicists.

March 18, 1700.—The inauguration of an Academy of Sciences at Berlin, after the plan of the Royal Society of London, was decided upon on Mar. 18, 1700. On July 11 the King, Frederick I., signed the letters patent which made it a State institution and Liebnitz was proclaimed president for life. The King, it is said, gave his consent to please his wife. In 1744 the Academy was re-organised by Frederick the Great, who attracted Euler, Lagrange, and other eminent foreigners to Berlin.

March 19, 1702.—In the *Post Man* of this date appeared an advertisement to the effect that Captain Savery's engine, which raises water by the "force of fire with less expense than any other forces of horses or hands" could be seen at his "Workhouse in Salisbury Court, London, against the old Playhouse." This 'Workhouse,' the first steam-engine factory in the world, was close to St. Bride's Church, Fleet Street.

E. C. S.

Societies and Academies.

London

Royal Society, Mar. 3.—**W. L. Bragg** and **J. West**: The structure of certain silicates. Each series of silicates classified together as a mineral species, although with wide variation in chemical composition, is regarded as based on a characteristic type of oxygen assemblage. A number of structures are based on cubic or hexagonal arrangements of closest packing of oxygen atoms, the metal and silicon atoms being inserted into this framework. The dimensions of the unit cell are related to the fundamental spacings of this simple background of oxygen atoms, on which the complex pattern formed by the other atoms is embroidered. Closest-packing is found for an extended series of compounds, ranging from BeO, Al_2O_3, $BeAl_2O_4$, and $MgAl_2O_4$ to cyanite Al_2SiO_5, olivine $(Mg, Fe)_2SiO_4$, monticellite $MgCaSiO_4$, and the chondrodite $[(MgOH)_2Mg_3(SiO_4)_2]$ group. The arrangement of oxygen atoms is in general more complex, closest-packing being an exceptionally simple case, but the packing of oxygen atoms seems to remain the predominant feature of the structure.

M. C. Johnson: Doppler effects and intensities of lines in the molecular spectrum of hydrogen positive rays. The luminosity of hydrogen positive rays was examined with apparatus capable of maintaining constant electrical and gas conditions over very long exposures. About 150 lines present in the positive ray spectrum are listed, and also about 100 strong lines conspicuous by their absence. Five lines with Doppler components not before recorded are found, including one displacement to the red. From measurement of the Doppler components in both atomic and molecular spectra, evidence as to the carriers of both is found. Certain lines are carried by H_2, and only one is probably carried by H_3. The displaced Balmer lines are due to free atoms, not to those newly dissociated. The Fulcher characteristics of the secondary spectrum weaken towards the violet, as also does the ratio of displaced to undisplaced intensities in the Balmer lines. The majority of the secondary lines are due either to radiation or to the impact of positive ions on stationary molecules which have not been recently ionised.

E. Mallett: A vector loci method of treating coupled circuits. If in the first of two coupled circuits an E.M.F. of constant amplitude and variable frequency is introduced, the currents in the primary and secondary respectively may be written $i_1 = e/Z'$ and $i_2 = e/Z''$, where Z' and Z'' are complex impedance operators. The loci of these impedances, as ω is varied, have definite geometrical forms; Z'' is a parabola, Z' a cissoid. Current loci are inverse of impedance loci. When the circuit condensers are varied instead of ω, the loci degenerate into straight lines and circles.

H. S. Allen and **I. Sandeman**: Bands in the secondary spectrum of hydrogen. A band in the secondary spectrum of hydrogen at higher pressures, recently described, comprising a P, Q, and R combination, was attributed to triatomic hydrogen. It has since been found to be one of a considerable system of bands which occur in groups, the bands of a group being spaced out at intervals of very nearly 92 wave-numbers, the spacing being in some cases approximately constant and in others conforming to a quadratic law. In some cases the lines of the groups are enhanced in the spectrum of the arc in hydrogen at higher pressures. The bands must originate in molecules with large moments of inertia, probably active or triatomic hydrogen.

C. G. Darwin and **W. H. Watson**: The constants of the magnetic dispersion of light. A review of various dispersion formulæ for the magnetic rotation of light shows the great practical advantage of Becquerel's, which determines an effective *e/m* from a comparison of the rotation with the refractive index. This formula is applied to all transparent substances for which the rotation has been measured: it is shown that no other theoretically possible terms are needed to represent the rotation. For hydrogen gas the ratio is unity, for all other observed substances less, ranging for the most part between 40 and 80 per cent. The only exceptional substance is oxygen gas, which completely refuses to fit any reasonably probable formula.

Royal Microscopical Society, Jan. 19.—**James A. Murray**: Nuclear degenerations due to multipolar mitosis (Presidential address). Personal recollections were given of the late Prof. Theodor Boveri, on whose material of disperm echinoderm eggs the investigations were carried out. A number of characteristic nuclear degenerations occur at a later stage of development in echinoderm eggs which have been fertilised by two spermatozoa and in which the first segmentation division is tri- or quadri-polar. The commonest form of degeneration involves a separation of the chromatin and achromatic parts of the nucleus with progressive condensation of the chromatin. Rarer forms of degeneration similar to the formation of chromidia and to the synaptic figures of gematogenesis may be of theoretical importance. Some of the commoner forms of degeneration could be recognised in tumour-like proliferations of lymphoid tissue in the mouse.

Society of Public Analysts, Feb. 2.—**T. Hedley Barry**: Arsenic in printing ink. Most of the printing-ink pigments contain arsenic, and it is possible to classify them into three groups on the basis of the amounts of arsenic present. A limit of 1 part of arsenic in 50,000 of the ink pigment should satisfy the most stringent requirements of health authorities; but this mode of expression is unsatisfactory, and it would be preferable to fix a limit of arsenic per unit area of the printed paper or wrapping.—**G. D. Elsdon** and **J. R. Stubbs**: The immersion refractometer and its value in the analysis of milk. The refraction of a milk serum apparently changes with two factors—the percentage of solids-not-fat, and the acidity of the milk. The decreased refraction due to added water may be entirely masked by the souring of the milk; up to 10 per cent. of added water may be entirely overlooked in this way. The examination of about one thousand mixed milks with a Zeiss immersion refractometer shows that the average refraction for milk serum, when the copper sulphate method is used, is about 38·3 scale divisions in the case of commercially fresh milks. The method offers no advantage over the usual determinations.—**Paul Haas** and **Barbara Russell-Wells**: Irish moss mucilage and a method for its determination. Irish moss, or carrageen mucilage, consists of a mixture of two ethereal sulphates. These can be determined by precipitation with benzidine chloride and titration of the washed precipitate with standard sodium hydroxide solution. Free sulphates, if present, are first precipitated by adding excess of barium chloride. The method can be used in the presence of gelatin, gum arabic, agar-agar, and fruit pectins.

Optical Society, Feb. 10.—**T. Smith**: Some uncultivated optical fields (Presidential address): (1) A graphical method, by which the properties of an optical system over the whole image field may be explored rapidly and with useful accuracy, is developed. The method is recommended for the investigation of 'best form' spectacle lenses, and for the preliminary exploration of new forms of photographic lenses. (2) The use of the characteristic function in the design of optical systems is discussed, and it is shown that it is always possible to construct such functions for optical systems having surfaces of any given shape. The optics of the future is likely to depend essentially on the use of the characteristic function. (3) The balancing of aberrations is also discussed. (4) As a special application of these methods it should be possible to design optical systems by calculations on equivalent lenses which are 'thin' in the usual sense. For the actual construction the equivalent 'narrow' lenses, or lenses which are just thick enough to attain the required aperture and strong enough to withstand treatment in manufacture, would be used. The correlation of the properties of 'thin' and 'narrow' lenses should prove a fruitful field.

Dublin.

Royal Irish Academy, Jan. 24.—**G. H. Carpenter**: Further records of Collembola from Spitsbergen. The paper comprises the results of the collecting and observational work done by members of the Merton College Expedition of 1923 and the Oxford University Arctic Expedition of 1924. The Collembola described were, for the most part, obtained from the far northern coast of the West Island and from the shores and islets of Hinlopen Strait between the West Island and North-east Land; the abundance of several species enduring the severe climate of this district is remarkable. *Isotoma olivacea* Tullb., found above the shore of Green Harbour, Icefjord, is an addition to the recorded Spitsbergen fauna, and a three-spined form of the common *Achorutes longispinus* Tullb. is noteworthy.

Feb. 14.—**A. W. Stelfox**: The Aculeate Hymenoptera of Ireland. The insects are grouped under the four super-families Apoidea, Sphecoidea, Vespoidea (including the Chrysididæ and Bethylidæ) and Formicoidea. A hundred and seventy-one species are definitely recorded as found in Ireland, and notes of their habits are given. Many of the commonest of British aculeates are absent from Ireland.

Paris.

Academy of Sciences, Jan. 31.—**E. Fichot**: The relation between the maximum velocity of the current and the amplitude of the tide.—**Paul Pascal** was elected a Correspondant of the Academy for the section of chemistry.—**Bertrand Gambier**: Surfaces which are not surfaces of revolution and have their geodesics closed.—**Henri Labrouste**: The analysis of the curves resulting from the superposition of sinusoids.—**S. A. Janczewski**: The theorems of oscillation of the regular problems of Sturm for ordinary linear differential equations of the fourth order.—**Walter Saxer**: Quasi-exceptional meromorph functions.—**R. Gosse**: W surfaces and surfaces of constant curvature.—**Beniamino Segre**: The integration of a certain system of differential equations.—**Nikola Obrechkoff**: The singular points of analytical functions.—**Louis de Broglie**: The atomic structure of matter and radiation and undulatory mechanics.—**P. Dupont**: The application of conjugated vortices to the aerodynamics of the circle and its profiles.—**R. Wavre**: The heterogeneous fluid mass in rotation and the internal movements of the planets.—**P. Helbronner**: The measurement of an arc of meridian of 8° amplitude, comprised between the north of the Jura and the south of Sardinia.—**Mlle. M. Hanot**: The enlargement of the Balmer lines by the intermolecular electric field. The widening of the lines is probably due to the Stark effect of the intermolecular field. According to the calculations of Holtsmark, the width of the line should be proportional to $n^{\frac{2}{3}}$, n being the density of the ions. Experimental confirmation of this is given, at least approximately.—A. Gargam de **Moncetz**: The chemical actions of radiations. Remarks on recent communications on this subject by H. Belliot and by P. Villard. Reference is made to results of experiments published by the author in 1908 and 1909.—**L. Meunier** and **G. Rey**: The determination of the isoelectric point of wool and silk. Applications.—**M. Wilmet**: The sensibility of some reagents to gaseous hydrogen sulphide.—**Auguste Lumière** and **Félix Perrin**: A new organo-metallic derivative of gold. A solution of sodium thiopropanolsulphonate is mixed with a concentrated auric chloride solution, when the new salt is precipitated. Its therapeutic application is suggested.—Emile **Saillard**: The coloration of products of the sugar factory.—**Ph. Joyet-Lavergne**: The action of osmic acid and the physico-chemical characters of the sexualisation of the cytoplasm.—Joseph **Devaux**: The existence and localisation of vertical ascending air currents in the neighbourhood of the Pic du Midi: their utilisation by vultures.—G. **Ollivier**: A Ceramium containing *bromuques*.—L. **Mercier** and J. **Villeneuve**: The controlling muscles of the lunule in *Eristalis tenax*. Sexual dimorphism.—P. **Vignon**: The ancestral origins of the dragon fly.—Mlle. S. **Perle**: The origin of the first genital outline in *Bufo vulgaris*.—G. **Athanassopoulos**: Certain migrations of eels in Greece.—S. **Posternak**: The phosphorus-containing nucleus of casein.

Brussels.

Royal Academy of Belgium, July 3.—P. **Bruylants** and A. **Dewael**: Contribution to the study of the action of organo-magnesium compounds on nitriles. Glutaronitrile and magnesium-benzyl-chloride. This reaction differs from that between the same nitrile and magnesium-phenyl-bromide: the product would appear to be a cyclic amidine.—Edm. **van Aubel**: The calculation of the refractive indices of mixtures and the formulæ of Dieterici and Lichtenecker. These two formulæ are applied to published data on mixtures of acetone-water, and sulphuric acid-water, and the Dieterici formula is shown to agree better with the experimental results for these two mixtures.—P. **Fourmarier**: Observations on the age of the sedimentary strata of the Belgian Congo exterior to the Lualaba system.—Th. **De Donder** and Fr. H. **van den Dungen**: The quantification of relativistic systems.—A. **Castille**: The ultra-violet absorption spectra of some substances with two benzene nuclei.—G. **Van Lerberghe**: The velocity of physico-chemical transformations.—Lucien **Godeaux**: A double plane of genus zero and bigenus one.—L. **Vuylsteke**: Contribution to the study of the reaction between organo-magnesium compounds and nitriles. Dimethylcyanamide.—Désiré **Tits**: The action of amino-acids on the germination of *Phycomyces nitens*.

Aug. 7.—Edm. **van Aubel**: The thermoelectric power of alloys. Experimental study of bismuth-thallium, antimony-tin, and antimony-silver alloys, from the point of view of the variation of the thermo-electromotive force with the percentage composition of the alloy. The curve of the bismuth-thallium alloys shows one definite compound, Bi_2Tl_3. The antimony-tin curve shows two discontinuities, corresponding to definite compounds Sb_2Sn_3 and $SbSn$, and Ag_3Sb is shown on the antimony-silver curves.—J. E. **Verschaffelt**: The variation of surface tension with temperature. The theoretical conclusions deduced by Van der Waals on the variations of the surface tension with temperature in the neighbourhood of the critical temperature are not in agreement with experiment. Van der Waals has assumed a perfect continuity of the equation of state in the neighbourhood of the critical point, and as this assumption is regarded as not legitimate, an alternative proof not assuming this continuity is given. The resulting equation is in fair agreement with experimental results.—Victor and Laure **Willem**: The influence of the respiratory movements on the cardiac pulsation in teleostean fishes.—R. **Moens** and H. **Steffens**: The thermionic phenomena in a magnetic field. The action of the magnetic field is shown by experiment to diminish the plate current and retard saturation.—G. **Homès**: Various energy balances of the Maxwell field plunged in a Minkowski field.—G. **Balasse** and O. **Goche**: The luminescence spectrum of cæsium produced in the discharge without electrodes.—A. **Piccard** and E. **Stahel**: The realisation of the Michelson experiment in a free balloon. The experimental error was of the same order as the positive results obtained, so that no definite conclusion can be drawn.

Rome.

Royal Academy of the Lincei, Dec. 19.—E. **Paternò**: The transmutation of the elements.—S. **Baglioni**, L. **Bracaloni**, and A. **Galamini**: Investigations on the physiological action of alcohol: the alcohol content of the blood of a fasting man following ingestion of alcoholic liquors. The curve showing the relation between the proportion of alcohol in the blood and the tissue since the alcoholic drink was taken varies greatly in form according as the subject of the experiment is or is not a habitual drinker. With the latter the maximum amount of alcohol in the blood is always reached, and this alcohol is dispersed, more rapidly than is the case with an abstainer. The subjective phenomena (drowsiness, incipient drunkenness, etc.) are related directly to the concentration of the alcohol in circulation in any one individual, and inversely to the rapidity with which, in different individuals, the alcohol disappears from the blood.—E. **Bortolotti**: Conform representations, and a new physical interpretation of Levi-Civita's parallelism.—L. **Fantappiè**: The theory of analytical functions in the integration of linear equations with partial derivatives of any order.—A. **Weinstein**: The analytical representation of certain aperiodic movements.—G. **Rossi**: The scintillation of the stars. A historical résumé is given as a preface to a description of experimental work.—A. **Carrelli**: The paramagnetism of the elements between calcium and zinc. As with the rare elements, so also with the elements constituting the group between calcium and zinc, spectroscopic data indicate a double period of variation in the number of magnetons as a function of the atomic number.—G. **Scagliarini**: Additive compounds of salts of quadri- and bi-valent elements with organic bases: probable nature of the secondary valencies.—F. **De Carli**: Reactivity of manganese dioxide in the solid state. Mixtures of manganese dioxide with the alkaline earths undergo exothermic reactions, which begin at comparatively low temperatures, namely, 150-250°; the mixture with cuprous oxide commences at 380° and that with stannous oxide at 180°. The oxidation of the dioxide is influenced by lead peroxide and by various anhydridic metallic oxides.—M. **Salfi**: Biology of *Clavelina lepadiformis* (Müller).—E. **Remotti**: Phenomena accompanying the crisis of sexual maturation of Gambusia. As regards oxidation processes, sexually immature forms of Gambusia exhibit uniform behaviour, interrupted only by the advent of sexual maturation, which acts differently in the two sexes.

Official Publications Received.

British.

The Ninety-third Annual Report of the Royal Cornwall Polytechnic Society. New Series, Vol. 5, Part 4, 1926. Pp. xliv-lviii+294-378+19+viii. (Falmouth.) 5s.

The South-Eastern Naturalist: being the Thirty-first volume of Transactions of the South-Eastern Union of Scientific Societies; including the Proceedings at the Thirty-first Annual Congress, held at Colchester, 1926. Edited by A. F. Ravenshear. Pp. ci+81. (London.) 5s. net.

Natural History Magazine. Vol. 1, No. 1, January. Pp vi+32. (London: British Museum (Natural History).) 1s.

The Scientific Proceedings of the Royal Dublin Society. Vol. 18 (N.S.), No. 30: *Caninia cylindrica* Scouler and other large *Caninias* from the Carboniferous Limestone of Ireland. By Herbert P. Lewis. Pp. 373-382+2 plates. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 2s.

Memorandum on Rivers Pollution submitted to the Right Hon. the Prime Minister by a Joint Committee of the British Waterworks Association and the Salmon and Trout Association (Supported by other Bodies). Appendix: Review of Recommendations of Royal Commissions, etc. Pp. 23. (London: British Waterworks Association.)

Proceedings of the National Laboratory of Psychical Research. Vol. 1, Part 1, January. Pp. 66+5 plates. (London.) 2s. 6d. net.

Proceedings of the Royal Society of Edinburgh, Session 1925–1926. Vol. 46, Part 4, No. 30: Experiments and Observations on Crustacea. Part vii: Some Structural and Physiological Features of the Valviferous Isopod Chiridotea. By Dr. John Tait. Pp. 334-348. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.) 1s. 3d.

Proceedings of the Cambridge Philosophical Society. Vol. 23, Part 5, January 31. Pp. 493-616. (Cambridge: At the University Press.) 7s. 6d. net.

Hampstead Scientific Society. Report of the Council and Proceedings, with a List of the Members, for the period October 1924 to September 1926. Pp. 62. (London.)

Records of the Survey of India, Vol. 21. 1: Air-Survey in the Irrawaddy Delta, 1923–24, by Major C. G. Lewis; 2: Reconnaissance Survey in Bhutan and South Tibet, 1922, by Captain H. R. C. Meade. (Published under the Direction of Col.-Comdt. E. A. Tandy, Surveyor-General of India.) Pp. iii+49+3 plates+2 maps. (Dehra Dun.) 1.8 rupees, 2s. 6d.

Report of the Seventeenth Meeting of the Australasian Association for the Advancement of Science, Australia and New Zealand, Adelaide Meeting, August 1924. Edited by L. Keith Ward. Pp. xliii+770. (Sydney, N.S.W.: Australasian Association; Adelaide: R. E. E. Rogers.)

Transactions of the Optical Society. Vol. 28, No. 1, 1926–27. Pp. ii+44. (London: Optical Society, Imperial College of Science.) 10s.

British Museum (Natural History), Cromwell Road, London, S.W.7. Summary Guide to the Exhibition Galleries. Third edition. Pp. 16. (London.) 2d.

Proceedings of the University of Durham Philosophical Society. Vol. 7, Part 3, 1925-1926. Pp. 107-163. (Durham.) 5s.

Agricultural Progress: the Journal of the Agricultural Education Association. Vol. 4, 1927. Pp. 186. (London: Ernest Benn, Ltd.) 5s. net.

List of the Officers and Fellows of the Chemical Society: Corrected to August 31st, 1926. Pp. 185. (London.)

Aeronautical Research Committee: Reports and Memoranda. No. 1048 (Ae. 234): Slot and Aileron Control on a Wing of R.A.F. 31 Section with various Types of Ailerons. By F. B. Bradfield and A. S. Hartshorn. (A.2.a. Stability Calculations and Model Experiments, 113.—T. 2294.) Pp. 16+10 plates. 1s. net. No. 1062 (Ae. 237): Full Scale and Model Measurements of Lift and Drag of Bristol Fighter with R.A.F. 30 Wings. Part i: Full Scale; Part ii: Model Experiments; Part iii: Comparison of Model and Full Scale Results. By A. E. Woodward Nutt, Dr. R. G. Harris and L. E. Caygill. (A.2.a. Aerofoils—General, 166.—T. 2322.) Pp. 6+9 plates. 6d. net. (London: H.M. Stationery Office.)

The Scientific Proceedings of the Royal Dublin Society. Vol. 18 (N.S.), No. 31: Studies on Peat. Part ii: Distillation under Reduced Pressure of certain Constituents of Peat. By Dr. Joseph Reilly and Joan Sullivan. Pp. 383-388. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 6d.

The Journal of the Institution of Electrical Engineers. Vol. 65, No. 362, February. Pp. 185-296+xxviii. (London: E. and F. N. Spon, Ltd.) 10s. 6d.

The Economic Proceedings of the Royal Dublin Society. Vol. 2, Nos. 17, 18, 19, February. 17: The Production of Essential Oils from Irish-grown Plants. Part ii: The Cultivation of *Mentha piperita*, and further Experiments on the Winning of Lavender Oil, by Dr. Joseph Reilly and Dr. Connell Boyle; 18: The Production of Essential Oils from Irish-grown Plants. Part iii: Oil of Peppermint. By Dr. Joseph Reilly and Dr. John Taylor; 19: The Production of Essential Oils from Irish-grown Plants. Part iv: Note on Oil of Camomile. By Dr. Joseph Reilly and Peter J. Drumm. Pp. 285-301. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 1s.

Foreign.

Publications of the National Academy of Sciences of the United States of America (1915–1926). Part i: Index to the First Ten Volumes of the Proceedings (1915–1924); Part ii: List of other Publications of the Academy from 1863–1926; Part iii: List of Publications of the National Research Council from 1916–1925. (Vol. 13, No. 1, Part 2, January 1927, Proceedings of the National Academy of Sciences.) Pp. 197. (Washington, D.C.) 1.50 dollars.

Carnegie Institution of Washington. Year Book No. 25, July 1, 1925, to June 30, 1926; with Administrative Reports through December 10, 1926. Pp. xix+451. (Washington, D.C.: Carnegie Institution.)

Department of Commerce: U.S. Coast and Geodetic Survey. Serial No. 366: Isostatic Condition of the United States as indicated by Groups of Gravity Stations. By William Bowie. Pp. ii+11. (Washington, D.C.: Government Printing Office.) 5 cents.

New Dynamical Wave-Theory of the Tides: Discovery of the Physical Cause of the Variation of Latitude, with Calculation of the Period and Amplitude of the Polar Motion, from the observed Oscillations of the Unsymmetrically situated Ocean Hemisphere, including a revised Cotidal Map of the Oceans, now shown to be Oscillating in Synchronous World-Waves coperiodic with the Disturbing Forces, Laplace's Principle, together with an Investigation of other Laws of the Motion of the Sea hitherto unknown, and an Improved Method for Calculating the Rigidity of the Earth. (H.O. No. 207.) (Published and Sold by the Hydrographic Office under the Authority of the Secretary of the Navy.) Pp. iii+91. (Washington, D.C.: Government Printing Office.) 60 cents.

Report of the Secretary of the Smithsonian Institution for the Year ending June 30, 1926. (Publication 2877.) Pp. vi+185. (Washington, D.C.: Government Printing Office.)

Smithsonian Miscellaneous Collections. Vol. 78, No. 3: The Classification and Distribution of the Pit River Indian Tribes of California. (E. H. Harriman Fund.) By Dr. C. Hart Merriam. (Publication 2874.) Pp. 52+27 plates. (Washington, D.C.: Smithsonian Institution.)

Annual Report of the Director, United States Coast and Geodetic Survey, to the Secretary of Commerce for the Fiscal Year ended June 30, 1926. Pp. iv+60+16 plates. (Washington, D.C.: Government Printing Office.) 25 cents.

Smithsonian Institution: United States National Museum. Contributions from the United States National Herbarium, Vol. 23, Part 5: Trees and Shrubs of Mexico (Bignoniaceae-Asteraceae). By Paul C. Standley. Pp. ii+1313-1721. 50 cents. Bulletin 134: Material Culture of the People of South-eastern Panama, based on Specimens in the United States National Museum. By Herbert W. Krieger. Pp. v+141+37 plates. 40 cents. (Washington, D.C.: Government Printing Office.)

Department of Commerce: Bureau of Fisheries. Document No. 968: Plankton of the Offshore Waters of the Gulf of Maine. By Henry B. Bigelow. Pp. 509+20 plates. (Washington, D.C.: Government Printing Office.)

State of Connecticut. Public Document No. 24. Forty-ninth Report of the Connecticut Agricultural Experiment Station, New Haven, Conn., for the year 1925. Pp. 721+26 plates+23T+xxxv. Public Document No. 47: State Geological and Natural History Survey. Volume 7, Bulletins 33-35, 1923-1925. Pp. 70+8 plates+307+20 plates+17. (Hartford, Conn.: State Library.)

Diary of Societies.

SATURDAY, March 12.

Institution of Municipal and County Engineers (South-Western District) (at Bath), at 12.

Royal Institution of Great Britain, at 3.—Dr. J. B. McEwen: Beethoven (3).

North of England Institute of Mining and Mechanical Engineers (Associates' and Students' Section) (at Newcastle-upon-Tyne), at 3.—The following paper will be read:—W. Britton: Systems of Conveying.—The following papers will be open for further discussion:—Screening and Washing Plant at Deaf Hill Colliery, by L. F. H. Booth; Steam and Electric Locomotives for Colliery Purposes, by P. F. Hope; Winning Thin Seams of Great Britain, by W. Leebetter; Dry Cleaning of Coal, by J. S. Carson.

MONDAY, March 14.

Cambridge Philosophical Society (in Cavendish Laboratory), at 4.30.—Prof. G. I. Taylor: An Experiment on the Stability of Superposed Streams of Fluid.—Dr. C. D. Ellis and W. A. Wooster: The Absolute Intensities of the γ-rays of Radium B and Radium C.—P. M. S. Blackett: The Limits of Classical Scattering.—J. A. Gaunt: The Stopping Powers of Hydrogen Atoms for α Particles according to the New Mechanics.—L. H. Martin: Absorption Coefficients for X-rays.

Royal Society of Edinburgh, at 4.30.—Sir Alfred Ewing: Exhibition of some of his Models illustrating the Molecular Process in Ferromagnetic Induction, which have been prepared for the Historical Collection in the South Kensington Museum.—Prof. J. H. Ashworth: The Distribution of Anopheline Mosquitoes in Scotland.—A. D. Hobson: Study of the Fertilisation Membrane in the Echinoderms.—*To be read by title*:—W. L. Calderwood: Note on the Salmon of the R. Grand Cascapedea, Canada.

Royal Geographical Society (at Lowther Lodge), at 5.—Prof. W. E. Soothill: Chinese Cartography.

Royal College of Surgeons of England, at 5.—Sir Arthur Keith: The Peoples of the East: Past and Present (6): Evidence bearing on the Distribution of Racial Types in Southern and Western Asia in Past Times.

Institution of Automobile Engineers (Birmingham and Wolverhampton Centres) (at Chamber of Commerce, Birmingham), at 7.—A. P. Young and L. Griffiths: The High-Tension Magneto, with especial reference to its Design, Manufacture, and Service.

Institution of Automobile Engineers (Loughborough Graduates' Meeting) (at the College, Loughborough), at 7.—C. Legge: Modern Motor Cycle Engines.

Institution of Electrical Engineers (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—F. H. Clough: The Stability of Large Power Systems.

Institution of Mechanical Engineers (Graduates' Section, London), at 7.—E. F. Cordell: Efficiency of the Repair Shop.

Institute of Metals (Scottish Local Section) (Annual General Meeting) (at 39 Elmbank Crescent, Glasgow), at 7.30.—G. W. Tyrrell: Moulding Sands.

Royal Institute of British Architects, at 8.—H. Robertson: Modern French Architecture.

Royal Society of Arts, at 8.—G. I. Finch: Some Industrial Applications of Electrothermics (Cantor Lectures) (1).

Institution of Electrical Engineers (Western Centre) (at Exeter).—R. B. Mitchell: Home Lighting.

Medical Society of London.—Dr. J. Forestier: Demonstration of Lipiodol Injections.

TUESDAY, March 15.

Royal College of Physicians of London, at 5.—Prof. F. R. Fraser: Cardiac Dyspnœa (Goulstonian Lectures) (2).

Royal Institution of Great Britain, at 5.15.—Dr G. Shearer: X-rays and the Chemical Molecule (1).

Royal Statistical Society (at Royal Society of Arts), at 5.15.—Sir Alfred Watson: National Health Insurance: a Statistical Review.

Royal Society of Medicine, at 5 30.—General Meeting.

Mineralogical Society, at 5.30.—C. E. Tilley: A Melilite-spurrite-Ca_2SiO_4 Assemblage from Larne (Antrim).—G. Greenwood: Rotating Crystal X-ray Photographs.—Dr. G. T. Prior: Alkaline Rocks from Nimrud Volcano, Armenia.

London Natural History Society (at 40 Winchester House, E.C.), at 6 30.—Dr. E. J. Salisbury: Woodland Vegetation.

Royal Photographic Society of Great Britain, at 7.—R. N. Speaight: Home Portraiture in Many Lands.

Institute of British Foundrymen (Lancashire Branch, Burnley Section) (at Municipal College, Burnley), at 7.15.—A. Buck: The Mixing of Cast Iron, with special reference to Carbon, Silicon, Phosphorus, Manganese, and Sulphur.

Royal Society of Medicine (Pathology Section) (Annual General Meeting), at 8.30.

WEDNESDAY, March 16.

Royal Irish Academy, at 4.15.

Royal Society of Medicine (Comparative Medicine Section), at 5.

Royal College of Surgeons of England, at 5.—Dr. H. Carlill: The Simulation of Surgical Affections by Hysteria.

Society of Chemical Industry (Liverpool Section) (Annual Meeting) (at Liverpool University), at 6.—Prof. J. C. Drummond: Bio-chemical Aspects of the Nature of Life.

Institution of Civil Engineers (Students' Meeting), at 6.30.—F. C. Jordan: Fire-Protection in Buildings, with special reference to Reinforced-Concrete Construction and Automatic Sprinklers.

Institution of Electrical Engineers (South Midland Centre) (Wireless Sub-section Meeting) (at University, Birmingham), at 7.—C. Robinson: Characteristics of Audio-frequency Amplifiers used in Telephonic Repeaters.

Institution of Electrical Engineers (Sheffield Sub-Centre) (at Royal Victoria Hotel, Sheffield), at 7.30.—Dr. W. H. Eccles: Address.

Merseyside Aquarium Society, at 7.30.—F. Jefferies: Aquatic Plants.

Royal Meteorological Society, at 7.30.—Prof. G. I. Taylor: Turbulence (G. J. Symons Memorial Lecture).

Royal Society of Arts, at 8.—Dr. R. E. M. Wheeler: History by Excavation.

Entomological Society of London, at 8.—Major R. W. G. Hingston: Protective Devices in Spiders' Snares.

Folk-Lore Society (at University College), at 8.—Exhibits and Short Communications.

Oxford University Junior Scientific Club, at 8.15.—Prof. H. E. Armstrong: The Failure of our Universities and their Future.

Society of Chemical Industry (South Wales Section) (at Swansea Technical College).—E. A. Tyler: Further Notes on Pure Chemicals.

Institute of Chemistry (London Section).

Society of Glass Technology (at Birmingham).

THURSDAY, March 17.

Royal Society, at 4.30.—Prof. W. L. Bragg and J. West: The Structure of Certain Silicates.—W. A. Wooster: The Analysis of Beams of Moving Charged Particles by a Magnetic Field.—J. F. Spencer and E. M. John: The Magnetic Susceptibility of some Binary Alloys.

Royal College of Physicians of London, at 5.—Prof. F. R. Fraser: Cardiac Dyspnœa (Goulstonian Lectures) (3).

Royal Institution of Great Britain, at 5.15.—J. Guild: Colour Measurement and Standardisation (1).

Institution of Mining and Metallurgy (at Geological Society), at 5 30.

Child-Study Society (at Royal Sanitary Institute), at 6.—Dr. J. R. Rees: Completion of the Education of the Parent.

Institution of Electrical Engineers, at 6.—Prof. W. M. Thornton: What is Electricity? (Faraday Lecture).

Royal Aeronautical Society (at Royal Society of Arts), at 6.30.—M. A. Giblett: Line Squalls.

Institute of Metals (London Local Section) (at 83 Pall Mall), at 7.30.—C. H. Barrs: The Works Chemist.

Chemical Society, at 8.—F. G. Mann: Tetrachloro-(triaminopropane γ-monohydrochloride) platinum, a New Type of Optically Active Complex Salt.

C.B.C. Society for Constructive Birth Control and Racial Progress (at Essex Hall, Strand), at 8.—A. S. E. Ackermann: Popular Fallacies connected with Birth Control.

Royal Society of Tropical Medicine and Hygiene (Laboratory Meeting) (at Royal Army Medical College), at 8.15.—Demonstrations by Drs. S. Adler, A. Balfour, Maj. J. S. K. Boyd, Maj. C. R. Chadwick, C. MacHattie, C. A. Hoare, Drs. Saiki, E. C. Smith, H. H. Scott, A. C. Stevenson, C. M. Wenyon, Prof. Warrington Yorke, and Dr. A. R. D. Adams.

Society of Glass Technology (at Birmingham).

FRIDAY, March 18.

Biochemical Society (Annual General Meeting) (at University College), at 4.30.—B. Holmes and E. Holmes: Carbohydrate Metabolism of the Brains of Normal and Diabetic Animals.—P. Eggleton and M. G. Eggleton: Phosphagen.—C. Rimington and H. D. Kay: The Phosphorus of Caseinogen.—Dr. R. K. Cannan and B. C. J. G. Knight: Observations on the Sulphydryl-disulphide System.—L. C. Baker and G. F. Marrian: Estimation of Adrenaline.—L. C. Baker, G. F. Marrian, and Prof. J. C. Drummond: Observations on the Adrenals of Rats with relation to Vitamin B.—S. Kon and Prof. J. C. Drummond: The Relation of Vitamin B Deficiency to Inanition in the Pigeon.—A. Hassan and Prof. J. C. Drummond: The Relation of certain Dietary Factors in Yeast to Growth on Diets rich in Protein.—H. J. Channon and A. C. Chibnall: The Presence of Calcium Salts of Glyceridephosphoric Acids in the Ether Extract of Cabbage Leaf Cytoplasm.—O. Rosenheim: Some Sterol Colour Reactions in their Relation to Vitamin A.—M. H. Roscoe: Some Observations on the Dual Nature of Vitamin B.—R. V. Stanford: (a) A Simple Automatic Apparatus for the Rapid, Quantitative Removal of Ammonia from Solutions; (b) The Pulsating Bubble: A Device for Preventing 'Bumping' in Boiling Liquids.

Royal College of Surgeons of England, at 5.—R. St. Leger Brockman: The Toxæmia of Acute Intestinal Obstruction.

North-East Coast Institution of Engineers and Shipbuilders (at Literary and Philosophical Society, Newcastle-upon-Tyne), at 6.—D. M. Shannon: Development of the Fiat Marine Oil Engine.

Institution of Mechanical Engineers (Informal Meeting), at 7.—F. E. Robinson: Some Aspects of Workshop Organisation.

Royal Photographic Society of Great Britain (Pictorial Group Meeting), at 7.—W. Thomas: Portraiture by Flashlight.

Photomicrographic Society (at 4 Fetter Lane), at 7.—Members' Evening.

Junior Institution of Engineers, at 7.30.—J. Calderwood: An Investigation of Tortional Vibration, with particular reference to Aircraft Engines.

Royal Institution of Great Britain, at 9.—E. Hatschek: Rigidity and other Anomalies in Colloidal Solutions.

Institution of Chemical Engineers (jointly with Coventry Engineering Society, and Society of Chemical Industry, Chemical Engineering Group) (at Coventry).—Prof. J. W. Hinchley: The Importance of Chemistry to the Engineer.

SATURDAY, March 19.

Geologists' Association (in Department of Anatomy, University College), at 2.30.—Prof. G. Elliot Smith: Demonstration of Fossil Remains of Man.

Association of Mining Electrical Engineers (North of England Branch), at 3.—C. D. le Maistre: Standardisation of Colliery Electrical Requisites.

Royal Institution of Great Britain, at 3.—Sir Ernest Rutherford: The Alpha Rays and their Application to Atomic Structure.

Physiological Society (at University College).—Annual General Meeting.

PUBLIC LECTURES.

SATURDAY, March 12.

Horniman Museum (Forest Hill), at 3.30.—Miss M. A. Murray: Trading in Ancient Egypt.

SUNDAY, March 13.

Guildhouse (Eccleston Square), at 3 30.—Major W. Tudor Pole: Universalism in Religion, with special reference to the Bahai Faith.

MONDAY, March 14.

University of Leeds, at 8.—Sir Bernard Pares: Present-Day Russia.

University College, at 8.30.—Sir Oliver Lodge: A Century's Progress in Physics (Centenary Address).

THURSDAY, March 17.

King's College, at 5.30.—Prof. L. T. Hobhouse: The Mind: Sociology.

University College, at 5.30.—Prof. J. Chevalier: Idéalisme et Réalisme. Le Français est-il Idéaliste? Est-il Réaliste?

SATURDAY, March 19.

Horniman Museum (Forest Hill), at 3.30.—H. N. Milligan: Animal Growth and Evolution.

CELEBRATION.

March 18 to 20.

Mathematical Association (Yorkshire Branch) (at Grantham).—The Two-Hundredth Anniversary of the Death of Sir Isaac Newton.

March 18, at 8.—Civic Reception by the Mayor of Grantham at the Guildhall, Grantham.

March 19, at 10 a.m.—Bicentenary Scientific Meeting in the Old School, King's School, Grantham, with addresses by:—
Sir J. J. Thomson: Newton's Work in Physics.
Sir F. Dyson: Newton's Work in Astronomy.
Dr. H. Lamb: Newton's Work in Mechanics.
Prof. G. H. Hardy: Newton's Work in Pure Mathematics.
Dr. J. H. Jeans will preside and give an address on Isaac Newton.
At 2.—Pilgrimage to Woolsthorpe Manor House (Newton's birth-place) and visit to Stoke Rochford, where Mr. C. Turnor will speak on Newton's Countryside.—At 7.30.—Celebration Dinner at the George Hotel, Grantham. Chairman: Sir J. J. Thomson. Speakers: Prof. H. H. Turner, Prof. E. T. Whittaker, the Bishop of Birmingham, and the Bishop of Lincoln.

March 20, at 11.15 a.m.—Bicentenary Service at the Parish Church, Grantham. Preacher—The Bishop of Birmingham.

CONGRESSES.

April 20 to 24.

Journées Médicales Marseillaises et Coloniales (at Marseilles).—Prof. Cantacuzène: The Rôle of the Streptococcus in the Etiology of Scarlet Fever.—Dr. Mayer: Recent Advances in the Treatment of Cancer.—Prof. Ottolenghi: Malaria.—Dr. N. Bernard: Beri-beri.—Prof. Imbert: Bone-grafting.

April 25 to 28.

German Society for Internal Medicine (at Wiesbaden).—Discussions on Psychotherapy, introduced by Gaupp and Fleischmann; Results of Recent Functional Investigations of the Stomach and Duodenum, introduced by G. Katsch.—A joint meeting with the German Röntgen Society will be held on April 26, with a discussion on the Significance of Röntgen-ray Examination of the Lungs and Mediastinum for Internal Medicine (excluding Tuberculosis), introduced by Distlen, Assmann Haenisch and Lorey, and Fleischner.

SATURDAY, MARCH 19, 1927.

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Scientific Method in Bibliography.

THE printed chronicle of human endeavour in all civilised countries of the world, in many tongues and recorded in multifarious publications, has long been accumulating at a rate so great, that not merely is its co-ordination beyond the power of any single mind, but also no central institution has been able to analyse it, so that this priceless store of knowledge may be made available for further advance.

At an earlier period, the author of a scientific or technical paper may have cherished the fancy that, by publishing his work, he was giving it to the world. To-day we have learnt by experience that to print a magazine article may be merely adding padding to a volume on the library shelf, for, without an index to recorded information, it is likely to become inaccessible. Nearly every one of that comparatively small band of workers who are patiently seeking to extend the boundaries of knowledge, to discover new and better methods of manufacture, or to invent and improve apparatus and machinery, must have realised the continual duplication of effort, which acts as an ever-present check to progress.

The lack of an extensive index to information was felt during the War; then machinery was hastily invented and methods of manufacture quickly devised, while the records of better apparatus and processes were lying buried on the library shelves. It is agreed that in peace and war a comprehensive guide to recorded knowledge would be an asset of the greatest value that would lead at once to important scientific and technical developments, while without it untold time and energy are being wasted throughout the world by the useless repetition of research and invention.

Various attempts have been made from time to time to collect, classify, and distribute information. A large number of publications are, or have been, devoted to the bibliography of special subjects; perhaps the greatest of all was the International Catalogue of Scientific Literature. There are, besides, many bureaux, both English and foreign, of divers types, engaged in the preparation of indexes to particular classes of information. Yet, in spite of all this activity, not the semblance of the desired key to knowledge is available.

This deplorable failure, which is restricting progress and prolonging unnecessary discomfort and inconvenience, may be due in great part to the lack of that which it is the purpose of bibliographies to supply; that is, information. For want of knowledge, bibliographical research is being undertaken everywhere, at home and abroad, without attention to the canons of bibliography or previous experience of its methods. Each abstracting or indexing body adopts a different system of classification and the abstracts or index slips are produced without regard to size, so that they cannot be mounted on cards and amalgamated with other bibliographies, and the information collected becomes hopelessly lost in thousands of separate parts. Moreover, every bureau indexes or abstracts papers that are done by, usually, a number of other bureaux, and only a fraction of the literature is covered.

The science of bibliography is not a subject of general study, and many scientific workers who realise the need of practical training in scientific method as well as knowledge of previous work appertaining to their special field of investigation, fail to understand that the same is true of bibliography. The would-be bibliographer must bring a scientific mind to the study of his task and must gain proficiency in bibliography by laborious practice. The indexing of scientific papers has also the added difficulty that the needs of scientific workers cannot be appreciated fully except by themselves. Thus an efficient index to scientific literature can scarcely be produced except by the application of a thorough knowledge of bibliographical science, wide experience in its application, and expert knowledge of the subjects indexed; that is to say, it is imperative that the scientific method be applied to bibliography.

Since the preparation of a complete index to published information involves the co-operation of many workers, it is necessary that a single system of classification should be chosen, which must be kept up-to-date by some central body. If, however, a definite classification were accepted and utilised by existing bibliographical undertakings, it would be possible to amalgamate their work into one series of cards which would go far towards the universal index desired. All information collected on a given subject would then fall together into one place to be available at need, and it would become apparent that identical information is being collected from the same periodicals by many different indexing agencies, and that information on a given subject is interesting to workers in many different branches of science or technology. By consultation, overlapping could be avoided, and energy, at present being wasted, could be used in indexing literature not dealt with hitherto.

The International Classification, described by Dr. S. C. Bradford elsewhere in this issue, is, ready to hand, such a scheme as is required for the preparation of a great index to recorded information, and no other suitable system is available. The general adoption of this code would make possible now the realisation of the index desired. Some thousands of bibliographies are in actual progress. At present their utility is very limited. But merely to number the bibliographical titles by the International Classification would make it possible to amalgamate them all into one index of the greatest value to mankind. The scheme has been utilised on the Continent as the basis of extensive bibliographies. The Classification is surely gaining ground and has received the support of the League of Nations. Recently, in Great Britain, the Optical Society has published an English translation of part of the Classification which has been used for the classification of the index to its *Transactions*. This can now be cut up, pasted on cards, and incorporated with other bibliographies numbered in accordance with the code.

When the International Catalogue of Scientific Literature came to an end, it was obvious that sooner or later the preparation of a comprehensive guide to scientific literature would have to be revived. The ideal solution to the problem has been suggested to be the building up of a National Science Library to take every important scientific periodical or publication together with a complete index to their contents, so that documentary research could be carried out in one building without waste of time journeying to different libraries.

As the Science Library at South Kensington contains an exceptionally extensive collection of scientific periodical literature, it seemed desirable that its resources should be developed so as to ascertain the possibility of realising such an ideal library. An organised effort is being made to augment the fine collection of scientific journals and transactions in the Library so as to make it as complete as possible. This has been so successful that periodicals are being added at the rate of a thousand or more a year, and the Library now includes between six and seven thousand of the items in the World List. The continuation of this undertaking, if possible on a somewhat larger scale, should lead in a few years to the gathering in the Library of a nearly complete collection of scientific periodicals.

After very careful consideration, the International Classification has been adopted in the Science Library for indexing the titles of its books and more important papers. The Library contains also sets of certain other bibliographies, as well as of some smaller undertakings based on the same system. All these are now being collected into one repertory, to which it will be possible to add any bibliographies that adopt this classification afterwards. The whole will be available for consultation in the Library together with the books, or from the index it should be possible to supply extracts by post at the cost of typing and postage.

The work of the past three years shows that the attainment of the first half of the ideal is possible. Its complete realisation would follow if it were possible for bibliographical undertakings generally to adopt the Decimal Classification of the Brussels Institute.

Atomic Structures.

(1) *The Progress of Atomic Theory.* By Dr. Albert C. Crehore. Pp. ii + 230. (London: Taylor and Francis, 1926.) 12*s.* 6*d.* net.

(2) *Die Welt der Atome: Zehn gemeinverständliche Vorträge.* Von Prof. Arthur Haas. Pp. xii + 130 + 3 Tafeln. (Berlin und Leipzig: Walter de Gruyter und Co., 1926.) 4·80 gold marks.

(3) *La fisica dei corpuscoli.* Per G. Gianfranceschi. Terza edizione. Pp. viii + 267. (Roma: Università Gregoriana, 1926.) 18 lire.

(1) THAT the Rutherford-Bohr atomic model, despite its remarkable success in explaining and correlating so many of the facts of physical and chemical science, is not yet universally accepted, is evident from a study of the first of these three books, the title of which will probably lead many who are unfamiliar with Dr. Crehore's writings to expect something quite different from what they will find. The book is really an account of the progress of the author's own particular atomic theory. Although we fancy that it will win few converts to his views, it is, nevertheless, not without interest.

Broadly speaking, Dr. Crehore believes, as so many of us would like to believe, that all atomic processes can be explained in terms of classical electrodynamics. It will probably be in the earlier chapters that the work will prove least convincing. Here the author describes the atomic models on which his subsequent calculations are based. We are told that the hydrogen atom consists of a nuclear charge of two units with two spheroidal electrons in contact with it, one on each side: similarly, the helium atom has a positive charge of four units, and on each side of this charge are two electrons closely bound to it. From these two fundamental atoms Dr. Crehore proceeds to construct the more complex atoms by a suitable arrangement of hydrogens, heliums, and cementing electrons. His atoms are more or less close-packed assemblages the linear dimensions of which are of the order of 10^{-13} cm.

The difficulties presented by such atoms are manifold, but if once the reader gets past these early chapters and accepts, even if only for the sake of argument, the hypotheses, he will find the subsequent chapters more logical. Indeed, in the development of his theory, Dr. Crehore shows no small courage and considerable mathematical skill in dealing on classical lines with these unconventional atoms. Perhaps the most interesting problem he sets himself is to explain why it is that atoms so small as 10^{-12} cm. should build themselves into solids in which they are separated by distances some ten thousand times greater than this. For this problem he claims a solution in the case of hydrogen.

The origin of a spectrum line of wave-length λ involves, according to this theory, an excursion of an electron to a distance $0{\cdot}05\lambda$. This applies equally to the optical and X-ray regions. In considering the latter spectra, the author emphasises the fact that this excursion is small compared with atomic distances in the solid. It is of interest to note, however, that recent direct determinations of long wave-length X-radiations would involve excursions considerably greater than the distance of closest approach of neighbouring atoms.

In spite of a bold defence of these atoms, which includes an explanation, based on them, of gravitation, there are still many gaps which will have to be filled and many difficulties which must be overcome before the majority of physicists will consider that the theory has progressed sufficiently far to replace that which is more or less generally accepted.

(2) If a course of Dr. Crehore has shaken, ever so slightly, the reader's faith in the conventional atom of to-day, it should be easy to restore it by a study of the second of these books. Dr. Haas is well known as a writer with a very considerable gift for clear and concise exposition, and this latest work worthily upholds this reputation. It is based on a course of lectures intended for a non-specialist audience and covers practically the whole range of modern atomic physics. That is a great deal to expect of a relatively small volume, but the author has selected his material with excellent judgment and woven it together into a convincing

narrative. There is no need to enter into the details of his presentation of the subject; suffice to say that he shows us that, whether we approach the problem of atomic structure from the point of view of optical spectra, X-ray phenomena, radioactivity, or any of the other lines, we are led to similar conclusions and to similar conceptions as to the nature of the atom.

If any one offers criticisms it will probably be the specialist, who may feel that the whole subject, as here presented, seems too simple, the interpretation of the facts too straightforward, the structure of the atom too obvious. This is a criticism which most authors will welcome. Too often a book which is perfectly sound from a scientific point of view is a very poor product when judged from a literary or artistic viewpoint, but Dr. Haas deserves our congratulations and gratitude for having written an account which is not only an up-to-date expression of the situation but also, above all, one which is readable.

(3) The third volume, by Dr. Gianfranceschi, is of a different type again. It is intended for the student rather than for the general scientific reader. As the title suggests, the author is concerned rather with the development of the electrical theory of matter than with the details of atomic structure. After preliminary chapters dealing with the basis of modern views of the structure of matter, he gives an outline of the kinetic theory of gases and its application to the theory of electrons. This naturally leads to a discussion of the problems connected with the passage of electricity through metals and kindred phenomena. Following the historical development, the author introduces the quantum by a short account of black-body radiation, and then proceeds to a brief description of modern theories of atomic structure and optical and X-ray spectra.

It might be expected that such a book would be full of somewhat abstruse mathematical analysis, but Dr. Gianfranceschi has succeeded in presenting his subject with the help of only such mathematics as every serious student of modern physics and chemistry may be assumed to possess. It is essentially a theoretical work, and experimental methods and results are introduced only in so far as they provide a basis for the theoretical discussion or a verification of the predictions of the theory. The fact that the book is now in its third edition is sufficient recommendation and sufficient proof that it has already proved its usefulness to a wide circle: without doubt, this new edition will be as popular as its predecessors.

The Endocrine Organs.

(1) *The Endocrine Organs: an Introduction to the Study of Internal Secretion.* By Sir E. Sharpey-Schafer. Second edition. Part 2: *The Pituitary, the Pineal, the Alimentary Canal, the Pancreas, and the Sex Glands.* Pp. xi-xxii + 177-418. (London: Longmans, Green and Co., Ltd., 1926.) 20*s*. net.

(2) *The Comparative Anatomy, Histology and Development of the Pituitary Body.* By G. R. de Beer. (Biological Monographs and Manuals, No. 6.) Pp. xix + 108 + 11 plates. (Edinburgh and London: Oliver and Boyd, 1926.) 12*s*. 6*d*. net.

(1) THIS volume completes the second edition of the well-known monograph upon the endocrine organs issued for the first time in 1916 and founded on a course of lectures (Lane Medical Lectures) delivered by Sir E. Sharpey-Schafer at Stanford University, California, in the summer of 1913. The second edition, in two volumes, has greatly outgrown its predecessor, and the second volume is the larger of the two, more than half of its bulk being devoted to the pituitary body. The other endocrine organs treated in it are: the pineal body, the duodenal and gastric mucous membranes in their relation to the production of secretin and gastrin respectively, the islets of Langerhans of the pancreas and the sex glands, including the interstitial cells of the testis, the ovary, and corpus luteum.

The histology of these organs is detailed and their structure illustrated by numerous drawings and photo-micrographs, all admirably selected and reproduced. Development of the organ is described in the case of the pituitary body, where its consideration is essential to a proper understanding of its differentiation with regard both to structure and physiological properties. The chemistry of the active principles produced by the organs and the history of the attempts to isolate them are recorded in so far as trustworthy evidence is forthcoming. Much, however, remains to be investigated in respect to the chemistry of the internal secretions, and the threshold of this subject has barely been reached as yet.

The physiological action of extracts of the organs, illustrated by admirable graphic records, and the history of their discovery, are fully detailed. The references to authors cited are exhaustive, and are given in foot-notes on the pages on which they are quoted, the value of the work being thereby greatly enhanced.

Clinical evidence bearing upon the effects of increase and decrease of activity of the organs has been wisely selected. The physician will find the book an invaluable one as an authoritative guide to the proper appreciation of what results may and may not be legitimately expected from the use of preparations of the endocrine organs as remedies. Unfortunately, the autacoids or self-remedies secreted by the endocrine organs do not lend themselves in all cases to a relatively simple method of employment such as is illustrated by the active principle of the thyroid.

The importance of the endocrine organs in physiology and medicine has long been established, but the grain is apt to be missed in the chaff, so abundant and varying in value is the literature of the subject. No one is better qualified than Sir E. Sharpey-Schafer to undertake the sifting required, and in these two volumes he has succeeded beyond praise in producing a standard work upon endocrinology which will be indispensable to the research worker and welcome to the physiologist and practising physician alike.

(2) This monograph, profusely illustrated by drawings in the text, and by special plates of photo-micrographs and one of coloured drawings, deals entirely with the morphology, histology, and embryology of the pituitary body. The various classes of vertebrates are considered, and in the concluding chapters the homologies of the gland are summarised, a scheme drawn up of its evolution, and observations made upon the types best fitted for experimental purposes.

The opening chapter gives an indication of the methods of preparation employed by the author. No mention is made of Flemming's solution, which, in the reviewer's experience, is by far the best fixative for the pituitary body, but requires a special technique in the subsequent procedure of staining. The author has entirely missed the histological evidence of secretory material in the pars nervosa, although it can be demonstrated in abundance in all types of vertebrates in which extracts of the posterior lobe yield an active pressor material. Harvey Cushing (Cameron Lectures, 1925) has indicated the importance of this material in the human pituitary, and has commented upon the surprising way in which it is ignored by many histologists.

Few references to the literature of the subject are made in the text, and the reader will find it impossible to distinguish between the original observations of the author and what has already been noted by others. This is a serious fault, and deprives the book of much of its value as a basis for further workers. An appendix gives a bibliography of works upon the pituitary published since 1913.

Most of the illustrations are original. The drawings are helpful, but references to them in the text are not always accurate; *e.g.* on p. 12 the reader is referred to Fig. 28 for an illustration of variations in the Golgi apparatus of the cells of the pars anterior of the mammalian pituitary, and on turning over a number of pages finds a line diagram of a transverse section of a fowl's pituitary. The photo-micrographs are far too crowded, and although well reproduced, lose in value because of their arrangement and the absence of an adjacent description.

To turn from criticism, it must be admitted that the author has recorded much work that is praiseworthy. Methods have been devised which appear to enable a differentiation to be made between pars intermedia and pars tuberalis. He has much to say that is interesting although one may not always agree with it, and his views upon the homologies and evolution of the gland cannot be lightly dismissed. P. T. H.

Our Changing Earth.

Our Mobile Earth. By Prof. Reginald Aldworth Daly. Pp. xxii + 342 (15 plates). (New York and London: Charles Scribner's Sons, 1926.) 21*s*. net.

PROF. DALY of Harvard once again has presented in book form matter of geological interest gathered from all parts of the world, and has supplied the desirable connective tissue of theory and speculation. The present work is based upon a course of popular lectures given at the Lowell Institute of Boston. Below the surface, however, it is easy to realise that it has been prepared for the serious student as well as for his lay brother. There is something of the fascination of Lyell's "Principles" in these traveller's tales, each one with its moral; and the suggested references listed chapter by chapter at the end of the volume will be found most useful. The 187 illustrations, too, are excellent; and an author's note invites their reproduction except where covered by previous copyright.

To begin with, we are introduced to earthquakes, with proper emphasis on their scientific importance as well as their frightfulness—fewer people are now killed by earthquakes than by motors. The localisation of earthquakes in the Tertiary mountain belts is explained as a result of up-and-down and sideways adjustments of already folded masses. Observed surface displacements are discussed with copious illustration. In passing, one may perhaps protest against ring-cracks being referred, in Fig. 10, to "torsion of the ground." These particular cracks are surely analogous to countless ring-fractures that a few years ago used to develop through settlement in relation to old shell-craters in Flanders. But to return from this aside, Daly not only illustrates surface faulting in connexion with the 1906 San Francisco earthquake, but also shows how the final snap was preceded by a more distributed distortion that has been traced in observations of the U.S. Coast and Geodetic Survey.

Daly next explains seismograms and the three kinds of earthquake waves distinguishable in these records. We are now getting to the heart of the subject. Advancing the usual arguments, our author claims that the continents are great discontinuous masses of aggregate granitic composition, and that they float in iceberg fashion with foundations immersed in crystalline basalt. He further suggests that below the crystalline basalt is a circum-mundane layer of *glassy basalt*, in which high temperature inhibits crystallisation. This conception has two important bearings upon volcanic and tectonic problems: it entails a limited inversion of the law of increasing density with increasing depth; and it also gives a higher subcrustal plasticity than might otherwise be expected. Probably many readers will hope that Daly will recast his theory to make his density inversion local as well as limited.

A chapter naturally follows on volcanic action. It is a valuable résumé, with much stress laid on Kilauea in general and gas-fluxing in particular. St. Helena is also mentioned as a geological paradise, and regret is expressed that Napoleon did not realise his opportunities in this direction.

An instructive attempt is made to disentangle earth and sea movement in comparatively recent phenomena of emergence and submergence. Jamieson's interpretation of isostatic earth-movement in connexion with ice-load is accepted as of prime importance for the understanding of the raised beaches of glaciated lands. On the other hand, a low raised beach, which Daly has traced along much of the shores of the Atlantic and Pacific Oceans, is attributed to a Neolithic withdrawal of water to augment some still existent ice-sheet. Similarly, Darwin's submersion theory of atolls is brought into relation with release of water during the wane of the glacial period. It would be interesting if some other isostatic expert were to approach Darwin's theory fortified with the apparently obvious assumption that all oceanic volcanic islands must in course of time subside.

The mountains of the globe are divided by Daly fairly comfortably into Mid-latitude-Mediterranean and Circum-Pacific zones. The nature of mountain folding and thrusting is illustrated, *inter alia*, by Fig. 148 of an overthrust outlier, Chief Mountain, Montana. In scenic expression it rivals the best of the Swiss *klippes*. Daly's outlook upon mountain problems is naturally reminiscent of the writings of Dana, James Hall (of New York), and Dutton, but it has notably original features. Here we need only point out that Daly joins Osmond Fisher, Dutton, Taylor, Wegener, and many modern alpinists in revolt against the old earth-contraction theory of mountain origin. He adopts instead the continental drift hypothesis, and adds new features. In outline, his statement is as follows:

(1) Continental drift is of the nature of a gigantic landslip—exceeding in scale the tectonic landslips envisaged by Schardt or Reyer.

(2) A cause is suggested for the continental doming that is supposed to have preceded continental slipping.

(3) The glassy substratum makes slipping easy.

(4) The slipping continents crumple marginal geosynclines.

(5) The glassy substratum allows of subsidence of crust-blocks beneath crumpling geosynclines, and the fusion and expansion of these blocks is responsible for eventual elevation of mountain chains.

A feature which continually crops up in Daly's discussion of mountains is an assumed lag between crumpling and elevation. In Europe, however, the evidence distinctly favours contemporaneity of these two phenomena (with, of course, later repetitions of upheaval in response to erosion as explained by Fisher in 1881). For example, the Tertiary Flysch and Molasse of Switzerland derived most of their material from already elevated Alps that were actually travelling. The travel was so real that the Flysch was in due course entirely incorporated in the Alpine chain, and even the Molasse, though it formed later and farther north than the Flysch, now lies marginally overturned and over-ridden.

E. B. BAILEY.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Band Spectrum of Mercury from the Excited Vapour.

IN my letter dated Mar. 1, which appeared in NATURE of Mar. 12, p. 387, it was stated that the 'forbidden' line λ2270 appeared in the excited vapour in association with the band spectrum.

I now find that the other 'forbidden' line at the computed position λ2655·60 also occurs in the excited vapour, and much more strongly than λ2270. The observed position of the line is λ2655·73. This measurement might doubtless be improved upon, but the line is very definitely on the less refrangible side of the line λ2655 13 in a comparison arc spectrum. The 'forbidden' line is absent from the latter, and, so far as I know, it has not been observed before in any circumstances.

RAYLEIGH.

Terling Place, Chelmsford,
Mar. 8.

Truth or Convenience.

DR. WILDON CARR's letter in NATURE of Feb. 5, p. 199, serves as a reminder that the mathematics of relativity is one thing and the philosophy based on it is another; so I take advantage of the opportunity to comment controversially on a few philosophic points, and especially to protest against a comparatively recent anti-scientific tendency to teach that we are not making an attempt to ascertain actual truth about the universe, but only to formulate propositions that are practically helpful and convenient.

In explaining the theory of relativity in ordinary language, stress is usually laid on the 'observer,' and at one time we were told that metaphysical ideas were evaded by attending solely to what could be observed with the aid of measuring instruments, and that thus physicists might be placated, since they were dependent on laboratory measurements for all their knowledge. But if physicists had proceeded solely on that basis, they would not have got very far in their generalisations and theories. The laws and conceptions of physics, like those of mechanics and geometry, are surely ideal; the exact truth of their propositions holds, not in the world of experience, but in an ideal world the axioms of which are infinitely true if true at all; experience might enable these theorems to be rejected as false, but their accuracy could not be tested by any precision of measurement, which must be limited to the fifth or sixth or perhaps the ninth decimal place.

The laws of motion, for example, and any other simple generalisation like Ohm's law, originate as hypothetical challenges, to be definitely disproved if possible, or to be verified approximately, or to be modulated by subsequent refinement, or to be applicable subject to certain conditions. Meanwhile they are taken as precisely true. Newton's law that acceleration is proportional to resultant force was treated as exact; the minor dependence of the ratio on speed was a discovery two centuries later. The constant ratio of e.m.f. to current in a metallic conductor may be modified by many circumstances of which the molecular disturbance caused by the current itself is chief. The law, moreover, may be found to apply to liquids, and be inapplicable to rarefied gases. Departure from an ideal law in any given case is a matter of measurement.

Truth is in the ideal. The actual world is an approximation thereto. No one has ever encountered an exact circle or triangle, but the Euclidean propositions apply to actuality as near as makes no matter. That is perhaps the excuse for saying that we do not aim at truth; but it is a bad excuse. We always aim at truth beyond the range of our experience or measuring achievements. Absolute truth may be an unattainable ideal, but it is our clear and permanent aim.

Similarly, the relativity axioms are incapable of any but approximate verification. They, too, belong to the ideal. This applies obviously to the equations, which as they stand are superhumanly accurate, but it also applies to the verbal interpretation or elucidation of such equations in terms of different observers. On no practical grounds can it be held that measurements made by an observer flying past the instruments, or the thing to be observed, are just as good as those made by one who is sitting still, and that we have no reason for preferring the observations of one more than those of the other. I take it that all the modes of statement in which different observers are mentioned are merely attempts to put into words, and thus make clear to literary philosophers, the meaning (say) of the Larmor-Lorentz transformation. From this point of view no doubt an 'observer' can be replaced by a photographic plate, except that neither a photograph nor anything else has a meaning until it is interpreted by a mind. But so far as the record is concerned, it does not matter whether the images are on the retina of the eye or on something else: the ultimate interpreter, in either case, is interpreting a physical record.

The exposition of the basal principles of relativity by Dr. Jeans in the new volumes of the "Encyclopædia Britannica" is a masterly production, and as he does not enter upon philosophy, save in a few subordinate sentences near the end, no fault can be found with it. But when it comes to an application of those principles to philosophy the ground is far less secure. The subordinate sentences I refer to in this fine article are where he says:

> "Relativity teaches us that this velocity [$c \pm u$] is always precisely c, and this in itself disposes of the ether of Faraday and Maxwell."

But surely the teaching of relativity on that subject is an assumption, based no doubt upon negative experiments and highly plausible, but not really verified; hence its force as an abolishing agent is by no means overpowering. It might even be said that the relativity rule for compounding any two velocities, u and v, essentially implies a medium in which the motions occur, because its characteristic constitutional velocity c is inevitably involved. Nevertheless it may be fully admitted that an ether subject to the ordinary laws of dynamics, so as to be illustrated by mechanical models, has had to be abandoned. All our science and natural laws have hitherto been limited to matter. Directly we go beyond that we are in the dark: somewhat literally our senses leave us. That is why I presume we are so loath to admit the existence of anything immaterial.

Again, it is said that it "is impossible to discriminate between gravitational and centripetal acceleration"; but surely one has relation to an axis, the other to a centre. At any given place discrimination may be impossible; but taking the whole surface of the earth into consideration it is not impossible. It is well known that they have been and must be discriminated: so, of course, the above is not Dr. Jeans's meaning, unless absolute rotation is abolished. But it is apt to be taken as his meaning, and so force or constraint gets abolished too.

Again, it is sometimes wrongly understood that two events are said by relativists to be simultaneous when a ray of light can be present at both. Or in the words of the philosophical article immediately following that of Dr. Jeans: "If a ray of light can move so as to be present at both events the interval is zero." Thus it might be understood that the flash of a pistol was simultaneous with its impression on the eye; or that the outburst of a solar flame or a new star is synchronous with the formation of its image on a plate. That is doubtless the appearance, but it has no reality. Every one really allows for time taken by the messenger. 'Interval' is a new technical term, involving both space and time, which may as it were partly or wholly cancel each other. The statement quoted above is only an interpretation of the usual expression for an interval ds in the so-called four-dimensional equation,

$$ds^2 = dx^2 + dy^2 + dz^2 - c^2dt^2,$$

with $ds = 0$ when light is concerned. In the interpretation of this equation, in which the velocity c has been introduced, that velocity is often called 1, and eliminated; but we cannot eliminate it from reality and regulate the nature of time or the sequence of events to suit any physical traveller. Zero interval does not mean simultaneity in time. The observer ought never to be allowed the last word. I suppose it may be truly said that thunder and lightning are really and truly simultaneous; but that cannot be the impression of any observer. Ascertained truth is the result of a mental operation superposed on mere observation. One observer may be as good as another, but an interpreter surpasses both.

Doubtless these objections are minor ones, and are not likely to be admitted without emendation; but there is a real tendency, initiated apparently by Mach, and pursued by Poincaré, to contend that physical generalisations are not so much true as convenient. And further, that all manner of absurdities can be tolerated, if they help us to arrive at results. Well, I admit that they can be tolerated in an interim manner; as in any consistent system of mathematics, $\sqrt{-1}$ and the rest are very useful; but they always disappear from the final result, or at least from the interpretation of that result. The tendency that I fear is that some of the absurdities will be retained by philosophically minded interpreters, and will be foisted into their scheme of reality. For example, in dealing with the quantum drop of an electron from one orbit to another, some writers seem willing to contemplate the extinction of an electron in one place and its re-creation in another; so that its world-line, instead of being continuous, is dotted. (I see that this very thing is illustrated in a letter immediately following Dr. Wildon Carr's.) Again I find in a review of a book by Prof. G. N. Lewis in Nature of Feb. 12, p. 228, an assumption that destination affects emission, or that an atom only emits light to or towards another atom; or in other words, "that we can influence events which are already past." So that, for example, the dark spaces in interference bands are to be accounted for by the light that would have fallen there being actually not emitted. This last contention, however, unlike some of the others, is demonstrably false; for we know that interference is only redistribution, and that extra light is accumulated in the bright spaces. Some popular statements about interference, however, have led people to suppose that light destroys light, not only locally but absolutely, in contradiction to the conservation of energy. Trivial errors like this may be of no consequence; but somehow people are led to say, what is actually said on p. 228, that the question of true or false "has no meaning in science. All that one is concerned with, as in the case of all scientific theories, is its usefulness." I venture to urge that contentions of that kind ought to be stigmatised and rebelled against as heresy.

There is a further but more recondite contention that our great physical generalisations (the conservation and relativity laws, for example) are not so much laws of Nature as identities, when properly regarded with full knowledge, so that their contrary is inconceivable. There may be some important philosophic truth in this, and perhaps it might be extended to include everything that is; so that, regarded from an impossible point of view of full and complete knowledge, everything is inevitable and could not be otherwise (unless this is limited to the inorganic world, and is not true of life and mind). However that may be, the discovery of these identities is the achievement of scientific exploration, and surely such identities are a real truth about the nature of things, and not mere human conveniences of expression. Regarded as conveniences, some relativity statements rather fail by not being convenient.

I know that this is a presumptuous letter, open to attack from many sides; but I do want to enter a protest against the idea creeping into scientific philosophy (not perhaps sufficiently guarded against by that admirable philosophic combination, the late James Ward and J. H. Poynting) that we are not out for truth, but only for handy methods of formulation; and, further, that we can contemplate absurdities, geometrical and other, not only as auxiliary and contemporary and intermediate aids, but also as representing something actually existing in the universe, although repugnant to our mental make-up. For mind, after all, is part of the universe,—by it our laws are formulated, and on it our test of truth depends. Minds are not infallible, however. It is therefore necessary to be cautious in stigmatising anything as an absurdity, lest its absurd aspect be only relative to our own incomplete experience and inadequate knowledge. Oliver Lodge.

Radio-activity and the Heat of the Earth.

While recognising the importance of the evidence brought forward by Dr. Lawson in Nature of Feb. 19, p. 277, I cannot agree that it is sufficient to demonstrate that only an insignificant portion of the energy emitted by radio-active elements in rocks is expended in effecting changes in the surrounding minerals. He states that when such elements are placed in glass tubing, the energy absorbed in producing modifications in the glass does not amount to more than one per cent. of the total given off and is probably not more than about a tenth of this value. He infers that a similar state of things must prevail where biotite mica instead of glass is exposed to the radio-activity, and this in spite of the fact that on heating the pleochroic spheres (usually referred to as haloes) that result, they "exhibit the phenomenon of thermo-luminescence," but claims that "the energy so liberated does not produce catastrophic results, and is manifestly small." The last statement is, to say the least, by no means obvious. The question at issue is simply quantitative, and it therefore seems to be dangerous to argue that because glass tubing containing about 70 per cent. of silica and a certain amount of lime and soda absorbs but a small proportion of the radio-active energy, this will also be the case with biotite containing, say, 38 per cent. of silica with smaller amounts of alumina, iron oxide, potash, and titanium oxide. That the alteration in the biotite caused by the radio-activity is very considerable follows from the fact that, as shown by Dr. Brammell of the Imperial College, the pleochroic spheres persist even when the biotite has been converted by pneumatolytic agencies into a substance practically identical with muscovite. He also found that it was necessary to keep biotite at a dull red heat for about six hours to render the 'haloes' invisible. During that time a very large amount of heat might be released without "catastrophic results."

Recently, records have been published of a deep boring at Dubbeldevlei in the Cape Province of South Africa (about Lat. 30° 30′ S. and Long. 21° 35′ E.), and they deserve consideration in connexion with this question. It reached a depth of approximately 5080 feet, and a survey by Prof. G. A. Watermeyer (*Trans. Geol. Soc. S. Africa*, vol. 26, pp. 65-7, 1924) showed that the depth could not be in error more than 0·3 of a foot. Temperature measurements were made by L. J. Krige and H. Pirow with the greatest care (*ib.* pp. 50-64). Down to 2137 feet the rocks consisted of horizontal Ecca and Dwyka beds, shales, with occasional dolerite sills, and tillite. Then came 550 feet referred to the Fish River Series, correlated with pre-Cambrian Pretoria Series. The remainder of the boring was in the ancient granites and gneiss which outcrop about fifty miles to the northward. They are widely extended in South Africa, not only at the surface but also below ground, as evidenced by fragments in the Kimberlite pipes (Du Toit, "Geology of South Africa, p. 44, 1926). They probably underlie all sediments except the primitive metamorphic rocks of pre-Witwatersrand age, into which they appear to be intrusive, and extend downwards for a depth of several miles at least. Being of acid composition they are presumably rich in radio-active substances. They must contain, too, a considerable amount of potassium, which Dr. Lawson claims as being radio-active.

The average temperature gradient for the whole depth of the boring was 1° C. in 31 m., but varied from 1° in 18·3 m. to 1° in 51·8 m., mainly in accordance with the conductivity of the local rock. In the granite and gneiss, the conductivity of which lies between 0·005 and 0·006, the average gradient was 1° in 45·4 m. In shale the gradient was at its highest, 1° in 18·3 m., for the conductivity of shale is stated to be only 0·0023. In the Witwatersrand mines the gradient is so low as 1° C. in 112·8 m., the conductivity of vein-quartz and quartzite being 0·0095, and that of pure quartz more than twice as much.

It is remarkable that the presence of extensive granite and gneiss in the lower 2400 feet of the bore, and for a far greater depth below, seems to have had no appreciable effect on the gradient. Unfortunately, no determination of the radio-activity of the rocks traversed appears to have been made. It is to be hoped that this will be carried out, as the cores are apparently still available.

JOHN W. EVANS.

'Seizure' with Sliding Surfaces.

IN his letter to NATURE on "The Polishing of Surfaces" (Feb. 19) Mr. N. K. Adam refers to Hardy's work on static friction, showing the tearing away of surface particles of glass when one glass surface slides over another glass surface. In a leading article, *Engineering* (Jan. 23, 1925) emphasises the difficulty in understanding how forces of cohesion, exerted through surface layers, can ever be great enough to overcome the forces of cohesion between a particle of glass on the surface and the particles of glass immediately below the surface, in order that a scratch may result. The writer in *Engineering*, as an alternative explanation, has recourse to ideas with regard to friction which Prof. Muir tells me were described so long ago as 1776 by Oliver Goldsmith in his "Survey of Experimental Philosophy": "The little risings in one body stick themselves into the small cavities of the other in the same manner as the hairs of a brush run into the irregularities of the coat while it is brushing. If the bodies slide one over the other, the little risings of one body in some measure tear or are torn by the opposite depressions."

What appears to me as a better explanation of the phenomenon of 'seizure' is afforded by the suggestion I made with regard to the polishing of surfaces (NATURE, Sept. 4, 1926), namely, that actual fusion of the surfaces occurs. The temperature at the point of seizure (one of the many points of 'contact' between plane surfaces) rises so high that actual fusion of the glass occurs across the surface layers, with subsequent rupture. It is only at first sight that this hypothesis seems extravagant, but Mr. N. K. Adam's reference (in the letter referred to above) to the "small thermal conductivity of the material," and his comments with regard to points of contact, indicate that some further explanation of the manner in which the thermal agitation is set up is desirable.

Space demands brevity, but there should be little difficulty with regard to the points of contact. Even such a material as wash-leather cannot possibly adjust itself to molecular irregularities. With regard to the setting up of the molecular agitation, it may be helpful if I refer again to the analogy of originating sound vibrations. My attention has been directed to a calculation made many years ago (I do not know by whom) showing that the natural frequency of sound or elastic vibrations of a particle of molecular dimensions is a high temperature frequency. Thus frequency $= \sqrt{E/\rho}/2l = \sqrt{10^{12}}/10^{-8} = 10^{14}$ per sec., and the frequency of the dominant wave length in black body radiation at a 'bright red temperature' is about 10^{14} vibrations per sec.

In conclusion, I would comment on Mr. Adam's statement that "Clearly the random removal of particles . . . from one point of the surface to another, must result in forming an amorphous layer, if continued long enough," by remarking that the ends of a freshly fractured glass rod do not cohere when pressed into contact again, and I do not understand how small fragments of glass in the polishing process can form an amorphous layer, polished or otherwise, without the intense molecular agitation or increase in temperature which gets rid of the surface layers.

JAMES M. MACAULAY.

Natural Philosophy Department,
Royal Technical College,
Glasgow, Feb. 24.

On the Volatility of Borax.

IN a discussion of the standardisation of hydrochloric acid with different standard substances (*J. Amer. Chem. Soc.*, 70, 1772, 1926), I made the following remark: "After the substance [borax] had been dried at 200°, the crucible was placed in an electric oven at a temperature of 700-750°, until constant weight was attained. When afterwards it was heated at 800°, at which temperature the salt fuses, the weight did not change. We cannot confirm the statement of H. V. A. Briscoe, P. L. Robinson, and G. E. Stephenson (*J. Chem. Soc.*, 122, 150, 1925), who state that fused borax loses sodium oxide. Even after the substance had been heated for two hours at 800° the weight did not change."

Prof. Briscoe and P. L. Robinson (NATURE, 118, 374, 1926), remark on this statement that the fact is well established that borax is volatile at high temperatures. They even were able to show in a qualitative way that fused borax is decomposed at higher temperatures. They say: "The inside of the silica muffle used for the fusions of borax in our investigation was completely coated with a white opaque enamel, about 0·06 inch thick, of a product of a reaction between the volatilised material and the silica."

As there is such a discrepancy between Briscoe's and my own results, I repeated the latter, but again I found a negligible loss in weight after two hours heating at 800°. Now Prof. Briscoe and his collaborators say they fused the borax in a *platinum dish* (large surface), in the electrically heated muffle in *a current of air* free from carbonic acid and dried over solid caustic potash. In total they heated it for 2-2½ hours. Hence they worked under conditions very favourable for volatilisation. In my experiments the borax was heated in a covered platinum crucible (surface of the fused borax about 2·5 cm.), without passing a current of air over it.

In order to check the results formerly obtained we heated about 3 gm. anhydrous borax in the electric oven under the same conditions as described.

We continued the heating for about fifteen hours at 880°, and afterwards twenty hours at 940°. At different intervals the borax was weighed (It is unnecessary to take precautions against hygroscopicity of the anhydrous salt, as the melt of borax with its small surface attracts water from the atmosphere very slowly. Even after standing in an open crucible overnight in the balance, the weight did not change.) From the results it appeared that the borax lost at 880° 0·16 mg. per hour, and at 940° 0·23 mg., due to the volatilisation.

We must therefore confirm the statement of Briscoe and his collaborators, that fused borax is volatile. *On the other hand, it is evident that under favourable conditions* (heating in a crucible without passing over it a current of air, and at a temperature of about 800°) *the loss due to the volatilisation of sodium oxide is so small that it is negligible, even for most accurate analysis, if the heating is not prolonged for more than two hours.*

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The Coat of Sheep.

In an important work, "Das Haarkleid des Menschen," published in 1908, Dr. Hans Friedenthal points out (1) that in man the coat between the fourth and fifth month of development consists entirely of fine wool fibres, and (2) that shortly before birth there appear among the fine wool fibres strong pigmented fibres with a pith or medulla, *i.e.* fibres corresponding to the coarse fibres forming the outer coat of wild sheep. Hitherto it has been assumed that the simple pithless fibres forming the coat of the Merino and other fine-wooled sheep are modified true hair fibres—hair fibres that have lost their medulla, from which, according to Bowman (the author of the standard work on wool), "the medulla has been bred out." From an investigation which has been in hand for some time on the structure of the fibre forming the coat of sheep, it has been ascertained that in sheep, as in man, the first coat consists entirely of simple pithless fine-wool fibres.

In the case of sheep, the gestation period lasts about twenty-two weeks. Though at the end of the twelfth week of development there are only a few fibres on the lips and at the tip of the tail, there is a complete coat at about the end of the fourteenth week. The fibres forming the first coat vary in length. In some areas they are so short that they are inconspicuous, in others they are nearly a quarter of an inch in length. The long fibres in sheep at the end of the fourteenth week, like the long eyebrow fibres in the human embryo, are obviously wool fibres. Though up to the middle of the fifteenth week the coat consists entirely of fine pithless wool fibres, at the end of the fifteenth week, more especially in the embryos of Highland Blackface and other coarse-wooled breeds, short coarse true-hair fibres with an interrupted or a continuous medulla are found among the fine-wool fibres of the first coat. As the development proceeds the coarse medulated fibres increase in number, and even in some fine-wooled breeds attempt to form an outer coat. In Europeans, as Friedenthal points out, there is, even in old age, usually a vestige of the first coat of wool.

In all wild sheep there is during winter a complete inner coat of very fine wool and an outer coat of coarse hair. Even in present-day domestic fine-wooled breeds there is always, on the head and limbs, a remnant of the original ancestral outer coat of coarse hair.

From this short account of the investigations in hand, it follows that a study of the coat of sheep during fœtal life lends no support to the view hitherto held by Bowman and others that wool is hair from which the pith or medulla has been bred out, but shows that wool is a distinct and primitive type of fibre different alike from fur and hair.

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Non-Magnetic Films of Iron, Nickel, and Cobalt.

The letter by Mr. Hanawalt and Prof Ingersoll on "Non-Magnetic Films of Iron, Nickel, and Cobalt" (Nature, Feb. 12, p. 234) raises a number of interesting questions.

Oseen's explanation (*Z. fur Phys.*, 32, 940; 1925) of the properties of the previously announced non-magnetic films of nickel was based on the supposition that 'non-magnetic' signified not only the loss of ferromagnetism but also of the magnetic moment of the nickel atom itself. An electronic rearrangement but no other change was postulated as a result of which the nickel atom obtained a completely symmetrical configuration, thus leading to a non-magnetic film in the above double sense. It may be pointed out that, while such an explanation could be extended to the case of iron, it would not be applicable for cobalt, as this atom contains an odd number of electrons.

It is not possible to state definitely from the data so far published whether the term 'non-magnetic' should be interpreted as in Oseen's paper or merely as indicating a loss of ferromagnetism as it is apparently intended. So far as the physical nature of the non-magnetic films is concerned, it seems that these may differ from the ordinary metals in bulk in that (1) the metallic atoms are farther apart; (2) chemical combination probably of a rather loose type may have taken place; and (3) there may have been an electronic rearrangement in the metallic atoms. (1) is shown to be the case from Hanawalt and Ingersoll's observations, and (2) is rendered probable. The reality of either (2) or (3) or both could be determined if it were possible to state whether the material of these non-magnetic films is diamagnetic or paramagnetic, and in the latter case, by measuring the susceptibility over a range of temperature, to evaluate the magnetic moment of the metallic atoms. The occurrence of paramagnetism would be consistent with the existence of change (1) with or without (2) and (3). A knowledge of the actual magnetic moment would probably enable a definite decision to be made as to the reality of changes (2) and (3).

If diamagnetism were found and the films of iron, cobalt, and nickel are really of a similar nature, then it would be very probable that all three changes had taken place. The metallic ions would then be in states which might correspond to that of iron in, say, $K_4Fe(CN)_6$, cobalt in most co-ordination compounds of tervalent cobalt, and nickel in, say, $Na_2Ni(CN)_4$.

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The Action of 'Antiknocks.'

THE following conclusions, amongst others, have been reached during an investigation on the effect of 'antiknocks'—such as lead tetraethyl—on 'knocking' in petrol engines:

(1) Antiknocks do not influence detonation in rapid combustion mixtures (*Proc. Roy. Soc.*, 114, 137, 1927).

(2) They function in the initial stages of the combustion as negative catalysts. In the slow combustion of a hydrocarbon, aldehydes are produced which readily form peroxides, which auto-catalyse or induce oxidation of the earlier stages. If these are removed, combustion proceeds more slowly. By reason of such effects on the processes of slow combustion preceding ignition, 'antiknocks' influence greatly the igniting temperature, particularly in the case of aldehydes. Similarly they effect those same processes which occur at a flame front in a comparatively slow burning mixture.

(3) Those metals which give effective organo-metallic antiknocks are found to be capable of forming higher oxides. Such metals as potassium, which form peroxides in equilibrium with other oxides at about 400° C. are very effective. Non-oxidisable metals such as gold are ineffective. The unstable peroxide formed in the combustion of the fuel and the metallic peroxide are considered mutually to destroy each other. The rate of destruction of the positive catalyst is greater than its rate of production, so that combustion is delayed. The metal atoms in a state of incipient oxidation are thus the effective anti-catalysts.

(4) A purely organic antiknock like aniline is effective for the same reasons; only those types of organic substances are effective as antiknocks as have been shown to be effective in retarding the oxidation of certain aldehydes at normal temperatures in the liquid phase. The mechanism adduced to explain their action in such circumstances by Moureu and Dufraisse is similar to that which we have given above. Such organic antiknocks themselves undergo combustion and are destroyed, a larger quantity of the negative catalyst being therefore required for the same effect.

(5) Both for 'ignition' and 'knocking' there is a condition of sensitiveness to change of reaction rate, and the effect of 'antiknocks' is in general much the same on the two phenomena. The views given are supported by the effect of such substances (aldehydes, organic peroxides, etc.) which promote knocking or favour ignitibility.

These conclusions elaborated and the experimental data which suggest them, will be detailed in papers which it is hoped soon to publish.

A. EGERTON.
S. F. GATES.

Oxford.

Electron 'Reflection' *in Vacuo.*

IN the *Proceedings of the Cambridge Philosophical Society* (Pt. 5, vol. 23), just received, there is an interesting article by Mr. C. F. Sharman on the application of the magnetic spectrum method to the study of secondary electron emission.

Several investigations of this type are now and have been for some time in progress in this laboratory, and we hasten to point out that at least one of our results obtained within the last six months has a bearing on Mr. Sharman's work. We find, in accord with him, that a fraction of the electrons emitted from a filament and accelerated towards a reflecting plate under potential V are 'reflected' with energy corresponding to that full potential V, and that energies immediately less than about 12 volts below V appear to be absent in most of the spectrum photographs taken. Generally speaking, there is a continuous spectrum starting at $(V - 12)$ and extending down to lower energies in an impartial manner. One of the two hundred or so photographs so far obtained is here reproduced (Fig. 1) with a potential scale in volts added for comparison. The sharp-edged black line in the spectrum at 238 volts shows the 'reflection' (from a copper target in this particular case) of the full energy electrons; there is then a white space, and thereafter a general reflection of all energies below about 226 volts. We think that this gap of 12 volts is in all probability real and not instrumental, as Mr. Sharman suggests. Our experimental results are in agreement with a short note by J. Becker (*Phys. Rev.*, 1924), in which during an investigation into the photoelectric emission from various surfaces a very similar effect was recorded.

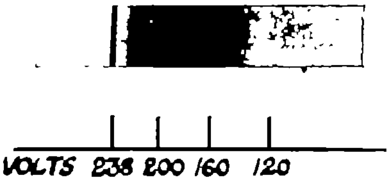

FIG 1.

D. BROWN.
R. WHIDDINGTON.

Physics Laboratories,
The University,
Leeds,
Feb. 17.

Is Darwinism Dead?

REFERRING to the correspondence in NATURE of Feb. 19, p. 277, Mr. H. Belloc writes to say that his statement regarding the impossibility of birds having been evolved from a reptilian form was based on Prof. L. Vialleton's "Membres et Ceintures des Vertébrés Tétrapodes" (1924), not, as Sir Arthur Keith had supposed, on that author's "Éléments de Morphologie des Vertébrés" (1911). The mistake seems to us to be immaterial to the question at issue—namely, "Is Darwinism Dead?"—and we suggest that it would not have occurred if Mr. Belloc had followed the usual practice of giving references to his authorities.

As to the particular point under discussion, it has been referred to the leading authority upon the subject, who replies: "It is absolutely certain that the birds came from reptiles." EDITOR, NATURE.

The Sun, the Earth's Atmosphere, and Radio Transmission.

By Prof. S. Chapman, F.R.S.

THE immense present-day importance of radio communication has directed the attention of a wider circle than ever before to the conditions prevailing at great heights in the atmosphere. Even to the professional meteorologist it seemed formerly that what happens above a height of 30 or 40 kilometres has no bearing on the practical affairs of humanity, however interesting the problems of these upper levels might be to the pure theorist. Almost the only influence of these levels upon the technical operations of mankind seemed to consist in the occasional interruption of telegraphic communication at times of great magnetic storms and auroral displays; the interference was pretty clearly due to currents induced in the earth and the cables by the rapidly varying magnetic field, but the direct association of the latter with the upper atmosphere was somewhat hypothetical, though the auroræ were quite indubitably atmospheric phenomena.

Now that signal transmission is not confined to cables, and electromagnetic oscillations over a wide range of wave-length are sent out into space, the upper air assumes more direct importance, for it is known that a large part of the energy transmitted to distant points travels intermediately at high levels. The manner in which the waves are affected in the upper levels is already partly understood; the rate of propagation is increased by the presence of ions, so that if the ionisation increases with height the upper part of a wave front travelling at an upward inclination to the horizontal is tilted forward, and the wave train may thus be refracted downwards again, quite sharp angles of bending being possible. At the same time, some of the energy of the wave, communicated to the ions, is lost by the latter during collisions with surrounding molecules; if the mean free path of the ions is short, and collisions frequent, the energy of the waves may be rapidly absorbed; the absorption increases with the density of the ionised layer, and is greater for long (low frequency) waves than for short waves. Moreover, the earth's magnetic field deflects the ions while they are oscillating under the influence of the waves, and brings about a change of polarisation of the waves, which is responsible for some of the errors in direction-finding by wireless.

These facts make it clear that changes in the ionisation of the upper atmosphere have an important bearing on wireless transmission, and should be carefully investigated in order that, if possible, the methods of signalling may be adjusted to the changing conditions. Probably in the future the upper atmospheric phenomena will become known by wireless investigations themselves with a thoroughness and detail not otherwise attainable—the results already achieved seem to promise this. But, at least in these early days of such work, some help towards the understanding of wireless problems may be gained from the knowledge slowly accumulated during three or four generations by the study of solar phenomena, auroræ, and terrestrial magnetism.

The ionisation of the atmosphere at high levels may be partly due to the penetrating radiation studied by Kolhörster, Hess, and Millikan, or by the runaway electrons the probable occurrence of which during thunderstorms has been pointed out by C. T. R. Wilson. It seems unlikely, however, that the ionisation thus produced is comparable in importance with that due to solar action. The magnetic variations are intimately connected with the ionisation of the upper atmosphere, and indicate its general distribution and its more important changes, which are unmistakably associated with the state of the sun, or its presentation towards the earth. Further study may reveal magnetic phenomena indicative of ionisation unconnected with the sun, but it appears improbable that such can be of the same order of magnitude as that of which the sun is obviously the cause.

The sun ionises the upper air by two independent agents. One of these travels rectilinearly and falls only on the hemisphere of the earth which faces the sun, that is, on the day or sunlit hemisphere. Many facts indicate that this agent is ultra-violet radiation, absorbed in the upper atmosphere, principally by ozone, itself produced by the first stage of such absorption; another consequence is that the temperature of the layer in question (extending upwards from about 50 km. height) is raised above that of the air at ground-level. As the revolving earth carries any particular region of the atmosphere into the night, when the ionising radiation is cut off, the ions re-combine, and most rapidly at the lower surface, which in the course of a few hours moves upward from a level of about 50 km. to 100 km. or more. The conductivity of the ionised layer is consequently diminished at night, by the reduction in both the thickness and the specific conductivity; this affects the electric currents flowing in the ionised layer, to which the daily magnetic variations are due The latter are much more intense by day than by night, and in low latitudes (where the sun's rays are most direct) than in regions farther from the equator. The magnetic variations also show clearly that the conductivity of the layer ionised in this way is distinctly greater (by at least 25 per cent.) at sunspot maximum than at sunspot minimum; this requires a change of intensity in the ultra-violet radiation by about 60 per cent., which is remarkable in view of the absence of any comparable variation, during the sunspot cycle, in the sun's visible radiation. The increase in the ultra-violet radiation seems to be due to enhanced emission from the sun's surface as a whole, and to be independent of particular disturbed localities on the sun.

The other solar ionising agent is corpuscular, and proceeds from locally disturbed areas on the sun's surface, often, though not always, associated with visible markings such as sunspots. The corpuscles are ejected in laterally limited streams, the direction of which varies as the sun rotates. When such a stream happens to impinge on the earth, the air becomes highly ionised in the atmospheric regions affected, which are situated geographically within about 20° of the poles of the axis of magnetisation of the earth, though they spread farther towards the equator when the streams are specially intense. The corpuscles can penetrate the earth's atmosphere down to not less than 80 km. above the ground; they impinge not only on the side of the earth facing the sun, but also bend round to the right side of the earth, where they produce visible auroræ. The deflexion of the corpuscles towards the magnetic poles is due to the earth's magnetic field, and indicates that the streams have a slight excess charge and are ionised.

The ionisation of the auroral zones renders these regions of the atmosphere highly conducting, and permits intense electric currents to flow in them; the changing magnetic field of these currents is observed as a magnetic storm (or lesser disturbance). Even if auroræ were not visible, the magnetic observations would indicate the existence of highly conducting upper air in polar regions.

The ionisation of the air due to the solar corpuscles is much less uniformly distributed than the ionisation over the sunlit hemisphere due to ultra-violet radiation; the limited distribution of bright auroræ gives visible indication of this. Also the ionisation by corpuscles varies irregularly with time, and cannot be predicted at present with any certainty; it depends both on the activity and presentation (towards the earth) of the disturbed solar areas. If such an area remains active after the lapse of a solar rotation period (about 27 days), it may affect the earth a second time, or even several times after successive rotations. Hence arises the clearly marked tendency for magnetic disturbance to recur after 27 days; but this is only a tendency, for the direction of the stream from a solar disturbed area may change, or the area may not remain long active.

The influence upon wireless transmission of the regular change of ionisation from day to night has long been recognised; the improved conditions at night, especially for long waves, are naturally accounted for by the withdrawal of the refracting ionised layer to greater heights at night, where the ions have longer free paths and where their less frequent collisions dissipate less of the energy acquired from the electric waves. The influence upon wireless of the less regularly distributed but occasionally very intense ionisation due to solar corpuscles has only lately become reasonably certain. The effects are likely to be complicated, and it will doubtless be a long time before they are clearly ascertained. An interesting feature suggested by recent observations is that transmission from Europe to America is more affected than that from Europe to the East. This is not unexpected, in view of the inclination of the earth's magnetic to its geographical axis; the centre of the north auroral zone is about 10° from the geographical north pole, in the direction of Canada, and auroræ are observed in Canada in much lower latitudes than in Europe. The region of abnormal corpuscular ionisation will therefore extend about 20° farther towards the equator in Canada than in Russia.

The Decimal Classification of Melvil Dewey and its Extension by the Brussels Institute of Bibliography.

By Dr. S. C. Bradford, The Science Library, S.W.7.

The study of classification is a necessary preliminary to the preparation of a comprehensive guide to recorded information. Of the multifarious systems that have been suggested for the classification of literature, Dewey's "Decimal Classification and Relative Index," first developed in 1873, seemed the most hopeful of any produced hitherto, and was hailed with jubilation in many quarters. But, although it proved successful for the purpose for which, in the first place, it was designed, *i.e.* the classification of books, it has been found inadequate when applied to greater bibliographical detail, such as individual scientific and technical papers. In its original form it is therefore unsuitable for the preparation of a detailed index to the records of human work and thought.

Dewey's scheme comprises two parts: a classification in which more or less logically arranged subdivisions of knowledge are given separate arbitrary numbers, and an alphabetical index of subjects, regarded by Dewey as the more important feature of the system, to indicate the respective numbers of the subdivisions. The index aims at giving similar or synonymous words and the same words in different connexions, so that any person of intelligence can scarcely fail to get the right number. In this scheme the whole of knowledge is represented by unity, and divided into ten main divisions. The first, comprising all numbers between 0·0 and 0·1, is assigned to works dealing with general subjects such as encyclopædias, bibliographies, etc., and those that cannot be allocated to the nine more definite subdivisions that follow. These are:

0·1 Philosophy.	0·6 Applied Science.
0·2 Religion.	0·7 Fine Arts.
0·3 Social Sciences, Law.	0·8 Literature.
0·4 Philology, Languages.	0·9 History, Geography, Biography.
0·5 Pure Science.	

Each of these main groups is again subdivided by addition of another decimal place, and further subdivision of these secondary and succeeding groups is obtained as desired. Thus:

0·5 Pure Science.	0·5315 Gravity, Ballistics.
0·53 Physics.	0·53157 Internal Ballistics and the Energy of Projectiles.
0·531 Mechanics.	

In practice the initial decimal point is omitted, and others may be intercalated to assist the memory or aid the eye. Thus catalogue titles, or abstracts, of books, pamphlets, monographs, papers, notes, etc., dealing with internal ballistics, are to be mounted on cards of uniform size and filed under the number 531·57; and no matter by what bibliographical agency the information is indexed, all the index cards relating to this subject fall together automatically. The student who requires to know what has been recorded on this subject, having ascertained the number from the alphabetical index to the subject-classification, can, by looking at the cards bearing this number, gain access immediately to all the information desired that has been rendered available.

The advantages of this system are: (1) Its simplicity: the order of filing is merely that of the decimal numbers, so that sorting of cards is mechanical; (2) each subject is represented by a single decimal number occupying a definite position in numerical sequence and independent of the language in which the conception is expressed; (3) nine further subdivisions can be obtained as desired by addition of one more figure, and these new subdivisions can be inserted between two previously established divisions without disturbing their numerical order; and (4) the number representing a given conception can be ascertained from the alphabetical index without consulting the classification.

Dewey's classification contains also the germ of an idea which, developed afterwards by the Brussels Institute, converted his classification into a powerful instrument of bibliography. There are certain general groups into which bibliographical material may be divided that are independent of subject, or common to a large number of conceptions. Thus, at the head of each of the main subdivisions (*e.g.* of 5, Pure Science), there is a section

01 Philosophy, Theories.
02 Compends, Text-books.
03 Dictionaries, Encyclopædias.
04 Essays, Lectures, Addresses.
05 Periodicals.
06 Societies, Transactions.
07 Education, Methods of Teaching.
08 Collected Works.
09 History.

Such subdivisions relate to the form or purpose of the work. For example, the *Proceedings* of the Physical Society would be numbered 53·06. Again under geology, 55, there is a section, 554 to 559, to be subdivided by countries like geography, 94 to 99. Altogether, a good many examples occur of the application of such an idea, but the classification, as published, was suitable for the purpose of arranging the books in the New York State Library, and the principle of common subdivisions was not developed in detail. If a universal guide to knowledge should be organised on the basis of the Decimal Classification, mankind will owe much to Melvil Dewey, and it is not the less to his credit that the original scheme proves inadequate when applied, as Dewey hoped, to the indexing of scientific papers as a whole.

However, the classification of separate articles requires much more subdivision than the grouping of works even on the largest scale. The main subject-classification itself requires to be more detailed, and when this has been developed as much as possible, there remain the various common aspects of a given subject to be dealt with. As an example, the number 661·25, in the extended classification, represents the sulphuric acid industry; and this requires to be further subdivided according to the process of manufacture. When this has been done, we have yet to provide for a variety of considerations that may apply to the number 661·25 or to its subdivisions. For example, there will be papers on theoretical or experimental studies relating to the manufacturing process, at the start, while in use, or after modification; papers from the point of view of realisation of the manufacture, such as gathering materials, special operations, raw materials, accessory products, machines employed, fixed machinery, engines, machine tools, implements, results obtained, by-products, fittings and apparatus; papers from the economic point of view, such as cost of materials, labour, selling price; and from the point of view of premises, sites, and personnel of various kinds.

These and other general points of view are common to the various branches of the sulphuric acid industry, as well as to a vast number of specific subject-divisions. Again, it will be necessary, in many cases, to classify bibliographical material according to place, time, or language, or, it may be, according to the form of the work. Thus, sulphuric acid manufacture may need to be treated from the point of view of country, or period, or it may be desired to distinguish between large treatises, manuals, books of tables, popular descriptions, collected papers or historical studies.

Now although, as it has been stated, Dewey's classification contains the germ of an extension by common subdivisions, this was not developed, and his tables have no places for grouping material by common headings such as have been mentioned. Indeed, to provide for such subdivision as necessary in each case, without perfecting a system of general classes, would have increased the size of the classification to several hundred volumes. For this reason his scheme in its original form is hopelessly unsuitable for the preparation of a comprehensive index to knowledge, and appears never to have been used for bibliographical work on a large scale.

This was the state of affairs when, in 1895, the first International Conference on Bibliography was held in Brussels. The Conference had to search in a spirit of impartiality for the principles on which could be established a universal bibliographical classification. It decided that the Dewey system was based on such principles and was capable of being transformed into a highly satisfactory classification. As a result of the Conference, the Institut International de Bibliographie was founded, which undertook the work of perfecting the Dewey code.

The classification itself was considerably extended, and, in addition, the conception of auxiliary tables for common subdivisions was developed. These are of two kinds: (1) Analytical subdivisions that relate to special subjects only, and (2) common subdivisions that may be added to any item of the classification. For example, general operations in photography are made into a group of special analytical subdivisions that are available for arranging matter relating to any of the various photographic processes. The numbers representing such subdivisions are preceded by a zero. For example, toning is one such division, represented by 0235, and this number can be added to any of the numbers representing a photographic process—thus 77·21 denotes silver processes in general, and 77·21·0235 means toning in relation to processes based on the use of silver salts.

Besides these special subdivisions that relate to particular parts of the classification, there are five tables of common subdivisions that may be used in any connexion. The first relates to the form of the publication, and is developed from the general subdivisions of the Dewey scheme described above, the numbers being enclosed in parentheses. Thus (05) represents a periodical, so that a magazine restricted to acetylene welding, for example, can be indicated by adding (05) to the number for that process as 665·882(05). Table II. comprises the geographical subdivisions. These are also enclosed in parentheses. Thus (493) denotes Belgium. Consequently sulphuric acid manufacture in Belgium would be 661·25(493). Table III. has subdivisions by language and Table IV. by time. The fifth of these common groups includes all subdivisions corresponding to general points of view. These are indicated by numbers commencing with a double zero; *e.g.* 00311 represents net cost of the raw materials. If it is desired to classify a paper on that aspect of the sulphuric acid industry, it would be numbered 661·25·00311; and these ten figures represent an idea requiring eleven words to express it in English.

By such a logical extension of Melvil Dewey's scheme it was converted into a beautiful bibliographical tool of the greatest power that is suitable for work of the finest detail; and in order that the classification may be kept up-to-date, a Commission was established to issue additions as needed. From time to time, with the progress of science and invention, new divisions become necessary and are published by the Commission. Or, an expert who discovers the need may suggest a considered extension of the scheme, and if this is drawn up in accordance with the principles of the classification, it will be incorporated.

Obituary.

Prof. E. H. Rennie.

Time irresistibly takes its terrible toll and the names left upon the roll of our old guard are now very few. The Australian mail just in brings me a copy of the Adelaide *Register* of Jan. 10, with an account of the sudden death of my old friend, Prof. Edward H. Rennie. He seemed to be in good health but on Saturday, Jan. 8, going into the garden, he took a drink of water, lay down—and just died. A few days previously, I had received a long chatty letter from him, dated Dec. 20. In this he speaks of having had a very strenuous year and feeling somewhat played out. During the first six months, he had been acting vice-chancellor of the University; then came the University jubilee and after this the meeting at Perth, of the Australasian Association for the Advancement of Science, of which he was president. Added to this, he had much anxiety on account of the illness of his wife and daughter. He tells me of the journey across the arid region to Perth, lasting three days. At one part, the railway runs in an undeviating straight line, nearly 400 miles, across flat desert, where nothing was growing, he says, over about 2 feet high, the horizon being unbroken by a single tree or elevation of any kind. People seldom realise how much of Australia is country of this order. "Aboriginals were seen here and there almost in their primitive condition, except that they wore clothes."

Rennie's first communication to the Chemical Society was made with Alder Wright. He then worked with me at the London Institution. The record of our work appeared only in the *Chemical News*. I was greatly attracted to him and was hoping to secure him as my chief assistant at the Finsbury Technical College, at the opening in 1883, but a more tempting offer came from home and he returned to Australia in 1882. Two years later, he became professor in Adelaide University. I visited him in 1914, reaching Adelaide a week ahead of the Association, in order to stay quietly with him. I then gained some idea of the man's devotion to his post and the great burden of work upon his shoulders. Rennie's services to his University as a teacher cannot be over-rated. He was extraordinarily thorough, deliberate and exact in his outlook and work, a most painstaking teacher. His scientific services to Australia are also to be ranked very high, though unfortunately, owing to the calls upon him as teacher and administrator, he had but little spare time for original inquiry. He devoted himself particularly to the study of native materials. Perhaps his most interesting discovery was that of trihydroxymethylnaphthaquinone in *Drosera Whittakeri*.

Australia is remarkable for its numerous species of long trailing Drosera. Rennie and I spent a delightful day in the hills behind Adelaide and nothing interested me more, in my journey around the continent, than his digging up the Drosera tubers and showing me the beautiful glistening crystals of the hydroxyquinone present in the outer layers. Why or wherefore such a compound should so come to the surface in a plant is difficult to say.

We spent another day on the seashore tracking down *Lotus australis*, which I was anxious to compare with our *corniculatus*. We found it in quantity, highly cyanophoric, very like the dwarf plant growing at Ballantrae in the sandhills. I fancy *corniculatus* must have wandered to the Antipodes and changed its name.

Australians are in no way sufficiently alive to the need of studying their natural organic products. The wonderful work on eucalyptus oils done by Smith and Baker of Sydney has not yet been appreciated. Only recently (Feb. 12), an advertisement was printed in Nature for a lecturer and demonstrator in organic chemistry, at the University of Sydney, salary £350 per annum. Only by accident is a chemist good enough for such a post likely to be bought at so low a price, perhaps that of a dock labourer—what Billy Merson earns in a week. No one there will rate a man very high who is paid such a salary. It were time that organic chemical science were put upon a higher footing, especially in so important a seat of higher learning as Sydney—so that it may have some chance of being mentioned along with the harbour.

Australia can ill afford to lose a man of Rennie's calibre and will do well to take warning and relieve them more of ordinary routine labours, if she find other such men to serve her.

Henry E. Armstrong.

Mr. A. B. Lee.

Arthur Bolles Lee, who died on Mar. 3 at Clarens, Switzerland, was born at Froyle, Hampshire, in 1849. He spent most of his life in Switzerland, and hence, though well known by name, was scarcely known personally in Great Britain. He was for several years an assistant under Prof. Korotneff in the Russian Marine Laboratory at Villefranche.

Mr. Lee was the author of a number of papers chiefly on oogenesis, spermatogenesis, and other cytological subjects, published from 1884 onwards, the last of which appeared in December 1924. But he was best known as the author of "The Microtomist's Vade-Mecum: a Handbook of the Methods of Microscopic Anatomy," first published in 1885. This work contained an account of all the methods that had, up to that time, been recommended for the preparation of microscopic objects whether as whole mounts or in section, and it became at once the standard work of reference on the subject. In the subsequent editions Mr. Lee judiciously discarded many of the older and less satisfactory methods as he added careful accounts of new processes, so that the "Vade-Mecum" was always a helpful guide to what had been proved best in methods of fixation, clearing, imbedding, section-cutting, staining and mounting of organisms and of tissues. Seven editions of this work in English up to 1913, at least two in French (by Lee and Henneguy) and four in German (by Lee and Mayer) afford evidence of the value and usefulness of this manual, which, indeed, formed part of the essential equipment of a zoological laboratory, where it was the source of reference on all matters of technique for senior students and for investigators. The last English edition (1921)—the eighth—was edited by Dr. J. B. Gatenby, but, as he stated in his preface, the bulk of the volume was still largely the work of Mr. Lee.

In recognition of his services to microscopical science, Mr. Lee was elected an honorary fellow of the Royal Microscopical Society. He leaves a daughter and two sons, one of the latter, Dr. G. W. Lee, being one of the Senior Geologists in the Scottish office of the Geological Survey of Great Britain.

A veteran botanist of striking personality, Prof. Ludwig Radlkofer, has recently been removed by death in his ninety-eighth year, on Feb. 16 last. He was born in Munich on Dec. 19, 1829, took the degree of M.D. at that University in 1854, of Ph.D. at Jena the following year, and in 1863 became professor of botany in his native city. He began his career as an author in 1855, soon being attracted to the Sapindaceæ, especially the genus Serjania, which he monographed in 1875, returning to it more than once, and continuing to write even so late as the last few months. He received many distinctions abroad, and was elected a foreign member of the Linnean Society of London in 1897. He claimed to have been the first to introduce the anatomical method in academical teaching, and was very anxious that his pupil, Dr. Hans Solereder (1860–1920), should be permitted to examine the Linnean herbarium and also the older plant collections in the British Museum such as the Clifford and Sloane herbaria. He introduced the topic at the Norwich meeting of the British Association in 1868 by his paper "On the Structural Peculiarities of Certain Sapindaceous Plants," and again in 1885 at Aberdeen "On the Application of the Anatomical Method to the Determination of the Linnean and other Herbaria." Needless to say, this proposal that every specimen should be so examined could not be entertained, as it involved the practical destruction of the types destined for the information of later generations of botanists.

B. D. J.

We regret to announce the following deaths:

Prof. D. Berthelot, professor of physics in the University of Paris (Faculty of Pharmacy) and *membre titulaire* for the section of general physics of the Paris Academy of Sciences, aged sixty-two years.

Kommandør C. F. Drechsel, General Secretary of the International Council for the Exploration of the Sea, at Copenhagen on Mar. 2, aged seventy-three years.

Prof. Carl Runge, professor of applied mathematics in the University of Göttingen, distinguished for his work as a mathematician and spectroscopist, early in January, aged seventy years.

Prof. A. W. Scott, for fifty-five years Phillips professor of science at St. David's College, Lampeter, on Mar. 7, aged eighty-one years.

Prof. Yovan Tsvyitch (Cvijić), of the University of Belgrade, president of the Yugoslav Academy of Science and an honorary corresponding member of the Royal Geographical Society, who was well known for his geographical, geological, and ethnographical studies, on Jan. 16, aged sixty-one years.

Dr. A. E. Verrill, from 1864 until 1907 professor of zoology at Yale University, and emeritus professor since 1907, who worked chiefly on marine invertebrates, aged eighty-seven years.

News and Views.

The new Sir William Dunn School of Pathology was formally opened at Oxford on the afternoon of Friday, Mar. 11. Unfortunately the Chancellor of the University, Viscount Cave, who was to have performed the opening ceremony, was prevented by illness from being present. The circumstances which led the Sir William Dunn trustees to make this magnificent presentation to Oxford were detailed by Mr. C. D. Seligman, the senior trustee present, and the building was gratefully received and declared open by the Vice-Chancellor, the Warden of All Souls, on behalf of the University. The objects of this munificent offer made to the University in Nov. 1922, subject to confirmation by an Order in the Court of Chancery of Feb. 1924, have thus been carried out. Of the total gift of £100,000, £80,000 has been devoted to the building and to its equipment, and £20,000 has been invested as a fund for maintenance and for the encouragement of the study of pathology. On the other hand, the University has provided a site of 2¼ acres near the south-east corner of the University Parks, and covenants to make permanent provision for the upkeep of a chair of pathology and for a full teaching staff. £3000 has, moreover, been allocated for the refitting of Prof. Dreyer's old Department of Pathology as a school of pharmacology—a subject which hitherto was poorly housed in attics under the roof of the old Radcliffe Library in the Museum.

The building which students of pathology in Oxford have now for their use is of red brick with stone coins, and is in three storeys in a simple and pleasing style of architecture, well lit by large windows. The main entrance leads up to the first floor, where are the lecture-room, museum, library, chemical laboratories and culture rooms. The large students' laboratory, and numerous research rooms are on the upper floor, while the service rooms, the refrigerating plant and cold chamber, centrifuge room, low-pressure apparatus room, engineering work-shop, store rooms, etc., are in the basement, whence a covered way leads to the animal house, an important two-storey building where there is accommodation for the live-stock and a caretaker. The requirements of any modern building for biological research are now of so varied a character that a gift for planning of a high order is needed to provide all needful accessories in suitable juxtaposition, and Prof. Georges Dreyer is much to be congratulated upon his great and obvious success in this matter. He now controls the finest scientific building in Oxford. The following inscription is placed on the main staircase:

> *Hoc aedificium A.S. MCMXXVI completum*
> *suppeditavit Gulielmi Dunn Baronetti*
> *munificentia pecuniis ingentibus ad levandos*
> *humani corporis dolores testamento devotis.*

In a paper read to the Institution of Electrical Engineers on Mar. 3, Commander H. T. Harrison discussed the problem of public lighting by electricity. He pointed out that, since the War, practically no advance in public lighting has been made in Great Britain. In America, on the other hand, good progress is being made in this direction. The town of Indianapolis, for example, installed a system of public lighting ten years ago. It has now completely scrapped the system, with the result that the illumination has been doubled with very little increase in the annual cost. The reason given for the change was that the great increase in automobile traffic made it necessary. Commander Harrison, who is responsible for many public lighting schemes, favours centrally suspended light sources for most business thoroughfares. In streets with buildings on either side, the span wires can be fixed to the buildings; in other cases they can be attached to steel columns set well back from the road so as not to offer obstruction to the traffic. He said that in shopping districts, where improved lighting benefits trade, it is easy to get permission to fix the span wires to privately owned buildings. If high-powered gas-filled lamps were used they would only want renewing about three times a year. Access to the lamps could be obtained by electrically propelled and operated tower wagons. Heavy batteries at the base would provide the necessary power and ensure stability.

Whilst we admit, with Commander Harrison, that economies could be effected in this way with improved lighting, we think that many will be opposed to span wires. It is true that the main streets of the city of London are lit in this way, but we think that the unnecessary multiplication of overhead wires is to be deprecated. In a gale of wind it is noticeable that the movements of the shadows produced by the vibrations of the lamps are objectionable. For lighting high roads and arterial roads passing through populated districts and used by motor traffic, Commander Harrison proposes that concentrated light sources at a considerable height above the ground should be used. In our opinion, such a solution would make special additional lighting arrangements necessary in foggy weather. Some of the lighting problems discussed, for example the relative advantages of having lights in the centre of the road or at the side where the reflecting power of buildings must be taken into account, will be of value in the theory of photometry.

Sir Flinders Petrie's preliminary report on the work of the School of Archæology in Egypt, which, owing to the conditions imposed on archæologists in Egypt, is now engaged in investigating the Egyptian remains on the Palestinean side of the frontier, describes the infertile conditions which have prevailed on the frontier during the current winter. These, however, have provided a more plentiful supply of labour than is normal, and have in this way been propitious for the initial year of the School's work in the area. The fortifications of Gaza have been examined, and a fourteenth-century B.C. wall revealed, of which the lower construction may be of Canaanitish age. The present state of desolation of much of the built-over area seems to offer a favourable opportunity for excavation, but much Roman material would have to be moved. In Sir Flinders Petrie's opinion, the site most likely to be profitable in historical results is that of Tell-Jemmeh, a mound about nine miles south of Gaza. The city was important in Hyksos times and flourished until about 1000 B.C., accumulating about 50 ft. depth of buildings. It was afterwards burnt and refortified, but its life ended about 500 B.C. A ruin in the neighbourhood named Umm Jerrar was supposed to be the Gerar of Abraham and Isaac, but this name probably belongs to the Tell. Gerar was of importance under the Philistine king Abimelech, but only appears once later under Asa in 940 B.C. During this season it is proposed to search thoroughly a fort with the surrounding buildings on the more prominent end of the Tell.

PROF. A. S. EDDINGTON, in his ninth Gifford Lecture in the University of Edinburgh on Friday, Mar. 11, reminded his audience that the typical laws of physics are not controlling laws; they are identities implied in the structure of the cycles of entities to which they refer. The controlling laws (if any) in the basal material are of a type which has not yet come within our knowledge. The physical universe cannot be completely subject to deterministic law unless mental states are also subject; it was for that reason that Prof. Eddington emphasised in an earlier lecture that through the new quantum theory physics is no longer pledged to a deterministic system—so that the nature of the governing laws of the mental substratum may be left open. After all, we have intimate acquaintance with a part of this substratum in our own minds. Prof. Eddington thinks that the hypothesis that this procedure is expressible by mathematical equations is scarcely plausible. We are disinclined to make this philosophical outlook too definite because we do not yet know how to place the physical laws of atomicity and quanta. The quantum theory is developing along rational lines, and this seems to suggest that the laws of atomicity will ultimately be assimiliated with the field laws by some profound extension of the idea of physical cycles. But the opposite view that whereas all other physical properties are due to our mental selection in world-building, the integral character of atoms and quanta is inherent in the basal world-stuff, is attractive. It reminds one of Kronecker's famous saying in pure mathematics—"God made the integers; all else is the work of man."

THE Friday evening discourse at the Royal Institution on Mar. 11 was delivered by Sir George Macdonald on "The Wall of Hadrian." Hadrian's Wall consists of the stone wall itself, the ditch in front, the series of forts, mile-castles and turrets which housed its defenders, and the earth-work in its rear known as the Vallum. Excavation has shown that the earth-work is certainly not older, and probably rather later, than the forts, and was not a military work but a civil or legal boundary. The forts, again, or at least some of them, have been definitely proved to be earlier than the stone wall. Thus we seem to get the chronological sequence—isolated forts, Vallum, stone wall. The evidence of pottery and coins suggests unmistakably that there was extensive destruction and restoration about A.D. 180, events that are certainly to be associated with the great rising in which southern Scotland was lost. The barrier was again swept about A.D. 270, and yet once more about A.D. 330. The final abandonment came about half a century later. In 1895, Prof. Haverfield and his colleagues of the Cumberland Excavation Committee discovered at Appletree a long stretch of wall built of turf, abutting at either end on the Wall proper, with which it did not seem otherwise to be organically connected. At first it looked as if the turf wall were going to provide a new and unexpected way of reconciling the rival claims of Hadrian and Severus, but in 1925 it (or another turf wall) was found six or seven miles farther east at Aesica, this time on the north of the stone wall and ultimately beneath it. Until further digging has taken place, it is unwise to theorise further. The key will probably be found at Birdoswald.

A PAPER read by Mr. H. N. Green at a recent meeting of the Illuminating Engineering Society dealt with a subject of great scientific interest, on which little is generally known—the use of artificial light in connexion with aerial navigation. Much care is now expended on the marking out of air-ways by beacons and the illumination of aerodromes to facilitate safe landing by night. The summit of a hill is not always the best site for a beacon. Hills are apt to be capped with clouds. It appears better to select a site slightly above the level of surrounding country and mount the beacon on a tower high enough to clear ground mists. Distinctiveness is usually given to beacons by flashing, the optical system rotating as a whole. But recently neon gas beacons, on account of the unmistakable colour of the light (red-orange) and the rapidity with which such lights can be flashed, have come into favour. It is even stated that the neon beacon at Croydon aerodrome can be seen in clear weather by pilots leaving the French coast. Effective methods of 'floodlighting' landing areas have now been introduced, and by means of lights sunk in the ground, pilots can be informed of the intensity and direction of the wind. The greatest difficulty is fog. Regular flying is not yet attempted at times when the visibility is very low. But pilots are liable to be caught in a mist, and in such circumstances can receive effective aid by means of directional radio, and the 'leader cable,' which carries a low frequency alternating current, and traces the correct route into the aerodrome. Once this cable has been picked up by the instruments on the aeroplane, the pilot can steer his way to the landing ground, where special lights assist his descent.

PART 12 of Volume 3 of the *Rendiconti della Reale Accademia Nazionale dei Lincei*, which has recently been issued, contains an account of the meeting of the Academy held on June 5, 1926, in the presence of the King and Queen of Italy. In his opening speech the president, Prof. Scialoja, referred briefly to the activities of the previous session. The library has been extended by the addition of premises adjacent to the Palazzo Corsini and should now meet the needs of the Academy for many years to come. The Copernican Museum, which was presented to Italy some years ago by the Pole, Wolinsky, and includes valuable records of the distinguished astronomer, together with old astronomical instruments and terrestrial and celestial globes, has been transferred from the Collegio Romano to a more fitting setting in the premises of the Academy. Among the donations announced were: the sum of 100,000 lire, given by the Bank of Italy, the Bank of Naples, and the Bank of Sicily, to celebrate the completion of the twenty-fifth year of the King's reign, to be awarded as a single prize for a thesis on the economic, financial, and social consequences of the European War; an equal amount, given by the Italian Banking Association, to provide a biennial prize; a similar sum, presented by the Assurance Company of Milan, on the occasion of its centenary, for the purpose of making a biennial award for scientific work bearing on insurance; 35,000 lire from the Italian Institute of Social Hygiene, to create two awards for investigations on the pathology of cancer and for work on social hygiene, and to furnish two gold medals to be given for work on social hygiene and industrial hygiene respectively; the sum of 125,000 lire, collected by public subscription in honour of Battista Grassi and presented by him to the Academy, to found an annual award for investigations on parasitology.

In the succeeding discourse, dealing with the conceptions of the atom and molecule due to Avogadro and Cannizzaro, Prof. Nasini protested against the opinion that, in the light of recent developments, the old fractional atomic weights correspond with mixtures similar to that present in sea-water and must be regarded as deposed. Prof. Nasini discussed the so-called 'Avogadro number' and is unwilling to consent to this magnitude being known as the 'Loschmidt number.' This name may justly be given to the number of molecules in unit volume of a gas for which Loschmidt was the first to determine an approximate value; the name 'Avogadro number' should, however, be retained for the number of molecules in the gram-molecular weight of any substance, this being a universal constant derived directly from Avogadro's law. Furthermore, although the ultimate particles of matter are now known to be the electrons and protons, and not the atoms, Cannizzaro made the definite statement that extension of the means of analysis available in his day might lead to further division of the atom of hydrogen, and later (1874) asserted that the atom contains parts capable of relative motion. The bearings on this question of the transformations of radioactive elements, of isotopes, and of the periodic law were also discussed.

The March issue of the *Nineteenth Century* contains an interesting article by Mr. Edwin Edser entitled "Science and Wonderland." Mr. Edser's thesis is that physical science has left the broad highway of logic and consistency and strayed into meadows where all is new, surprising, and paradoxical—the wonderland to which his title refers. While practically all men of science must agree that the present position, with its coexistence of wave theory and quantum theory, and the difficult physical implications of the generalised theory of relativity, is full of paradoxes and trouble, it is open to question whether Mr. Edser's presentation preserves due proportion, and whether his particular criticisms are really cogent. He urges that an ether must exist by means of such arguments as, "If light is propagated through space in the form of waves, the space must be occupied by a medium which can propagate the waves. To speak of the propagation of waves in an empty space is as meaningless as to discuss the propagation of the human race in an uninhabited country."

The real question, however, is not whether we use the term 'ether' or not, which is a question of words, but what meaning and properties we are to attribute to the ether. Einstein himself is quite ready to call empty space in which gravitational and electromagnetic fields prevail the 'ether,' but the properties of this ether are not the traditional mechanical properties which it was formerly sought to attribute to it. Mr. Edser's discussion of the theory of relativity, to which much of the article is devoted, gives a comparatively long account of the Michelson-Morley experiment. No distinction, however, is made between the special and the generalised theory, which are not even mentioned separately by name, while it is definitely suggested that the influence of gravitation on light was predicted by Einstein on the basis of a corpuscular theory. Again, the discussion of the quantum theory of spectra is not very satisfactory, for the statement that in the atom "only those orbits are possible in which the kinetic energy is equal to an integral number of quanta," scarcely represents the essence of Bohr's theory, as usually understood. There is no reference to the new quantum mechanics of Heisenberg and his followers, the general trend of which can be put quite simply.

The inclusion of Boyle's experimental notes on the mechanical origin of electricity and the mechanical production of magnetism in the "Old Ashmolean Reprints" being issued by Dr. R. T. Gunther (Magdalen College, Oxford. 3s.) was a happy thought. The notes give a clear account of the experimental knowledge and the orthodox theories of the subject current in 1675. We read how, when amber is rubbed or heated, it emits rays or "files of unctuous steams," which, when they become a little cooled by the external air, shrink back to the amber and carry with them any light bodies in the neighbourhood. Boyle points out how odoriferous gums and perfumes send forth fragrant steams when heated. Apparently navigators and others of that period were willing to pay the owner of a good lodestone to have their needles, swords, knives, etc., magnetised. It is also interesting to read how a bar of steel placed vertically acquires a temporary 'verticity' (polarity), and how when its direction is reversed the polarity is often reversed also. This was one of the experiments

Lord Kelvin used to show in his lectures on magnetism to students. He demonstrated also, like Boyle, how unstable was the induced magnetism.

DR. GEORGES SCHREIBER in an article in *The World's Health* for February discusses the important question, "Should a medical examination before marriage be obligatory ?" In a few of the United States a pre-nuptial certificate is necessary as regards the absence of venereal diseases, and in some States, in addition, absence of tuberculosis, epilepsy, and alcoholism. While generally restricted to the male, in two States the woman must also present a certificate. In other States a declaration on oath without medical examination is required. In the Netherlands, France, Germany, and Austria, pre-nuptial medical examinations are advocated by the health authorities, but there is no compulsion. In Scandinavia the registration by a doctor of a declaration on oath by the contracting parties as to their state of health is required. Dr. Schreiber considers that there are many objections to a compulsory pre-nuptial medical examination, and that the Scandinavian system seems to provide the most equitable, the most efficacious, and simplest safeguard.

AT a recent meeting of the Zoological Society of London, Lord Rothschild exhibited a mounted specimen of *Varanus komodensis*, the 'Dragon' of Komodo Island, Dutch East Indies. Specimens of other species were also shown for comparison. Much has been written lately about this, the largest of the lizards, but most of the statements are much exaggerated. The type-specimen is 12 feet 4 inches in length. None now alive on the island exceeds 10 feet in length, but their bulk is very considerable. The interesting feature of the Komodo monitor, apart from its bulk, lies in its relationship. The twenty-two other Indo-Australian species all have smooth scales, with one exception, tails much longer than the body, and narrow heads; *V. komodensis*, on the other hand, has the scales much raised with a central keel, a comparatively short tail, and a broad blunt head; in these respects it resembles the much smaller West African lace-lizard *V. albigularis.* The only Indo-Australian Varanus showing raised scales, and these on the hind neck only, is *V. rugicollis* of Borneo, but this is a small slender species. *V. salvator* of western Malayasia and *V. giganteus* of New Guinea come near to *V. komodensis* in length, examples nearly reaching 8 feet being on record; but neither ever approaches this species in bulk, a 10-foot specimen of which weighed 3 cwt. alive.

THE Ural region has a special interest for archæologists, lying as it does on the route of migrations of prehistoric races between European Russia and Siberia. During the bronze age the region was one of the main centres of mining industry, as is evidenced by numerous remains of primitive mines. A still earlier period left its traces in various sites of palæolithic culture. But most interesting of all are numerous finds of wooden objects like boats, figures of gods, etc., which occur in the pith-deposits near the main ridge of the Ural mountains; these remains are similar to those found on the sites of ancient lake settlements on piles in Switzerland. No systematic investigations have been so far undertaken in the Ural region, but the Russian Academy of Sciences is organising a special expedition there in 1927.

THE Council of the British Association has nominated Sir William Bragg as president of the Association for the meeting in Glasgow in 1928. Rapid progress is being made with the arrangements for the forthcoming meeting in Leeds this summer, under the presidency of Sir Arthur Keith, and it is expected that a preliminary programme will be issued in April.

DR. HAROLD JEFFREYS has been awarded the Adams Prize for the period 1925-26 for an essay on "The Constitution of the Interior of the Earth, and the Propagation of Waves through the Interior and over the Surface of the Earth." The prize is awarded by the University of Cambridge every two years for an essay on some branch of pure mathematics, astronomy, or other branch of natural philosophy, and is of the value of about £250.

THE executive committee appointed to make arrangements for an International Botanical Congress in England in 1930 has decided that the Congress shall be held in Cambridge, commencing about the middle of August. The following officers have been appointed: *Chairman of the Executive Committee*: Prof. A. C. Seward; *Treasurer*: Dr. A. B. Rendle; *Secretaries*: Mr. F. T. Brooks and Dr. T. F. Chipp.

IN a letter to the editor, Mr. A. G. Tarrant refers to the sympathetic attitude displayed in the leading article in NATURE of Mar. 5 towards the appeal which is being circulated by the National Union of Scientific Workers. He raises the problem of the unqualified practitioner in science, and states that unless a definite assurance is given by the executive of the Union that it does not include any such workers in its membership, it will meet with opposition from members of such bodies as the Institute of Chemistry and the Institute of Physics. We have communicated with the general secretary of the Union, who informs us that it is definitely stated in the rules that one of the objects is "to insist on a legally recognised qualification for all scientists engaged in the practice of science for remuneration," and that "only those who possess a recognised degree in science, mathematics, or technology, or other qualification recognised as equivalent thereto," are entitled to the privileges of membership.

AT the annual general meeting of the Society of Public Analysts, held on Mar. 2, the following officers were elected: *President*: Mr. E. Richards Bolton; *Vice-Presidents*: Mr. R. L. Collett, Mr. C. H. Cribb, Mr. John White; *Hon. Treasurer*: Mr. Edward Hinks; *Hon. Secretary*: Mr. F. W. F. Arnaud.

MR. A. E. MOURANT, Department of Geology, University Museum, Oxford, writes asking for reports of the earthquake which affected lands bordering the English Channel shortly before 11.30 P.M. on Feb. 17:

Further information regarding the shock of July 30 last would also be welcome (see Nature, Aug. 7, 1926, p. 204).

Applications are invited for the following appointments, on or before the dates mentioned :—A pathologist at the Charing Cross Hospital Institute of Pathology—The Secretary, Charing Cross Hospital Institute of Pathology, 62 Chandos Street, W.C.2 (Mar. 23). A junior scientific assistant for Admiralty research—The Secretary of the Admiralty (C.E. Branch), Admiralty, Whitehall, S.W.1 (Mar. 26). Two junior technical officers in an Admiralty Experimental Establishment—The Secretary of the Admiralty (C.E. Branch), Admiralty, Whitehall, S.W.1 (Mar. 26). An assistant in the Liverpool Observatory, Bidston—The Mersey Docks and Harbour Board, Liverpool (Mar. 31). Six forest officers for service under the Government of Burma—The Secretary to the High Commissioner for India, 42 Grosvenor Gardens, S.W.1 (April 1). A scientific officer under the directorate of scientific research, Air Ministry, primarily for research in connexion with electrical ignition appliances—The Chief Superintendent, Royal Aircraft Establishment, South Farnborough, Hants (April 6, quoting A. 81). An adviser in agricultural entomology in the University of Manchester—The Registrar, University, Manchester (April 19). A professor of anatomy in King's College, London—The Academic Registrar, University of London, South Kensington, S.W.7 (April 21). An instrument maker for experimental work in the Experimental Department of the Fine Cotton Spinners' and Doublers' Association, Ltd., Rock Bank, Bollington, Macclesfield—The Secretary. A demonstrator in the mechanical engineering branch of the Artillery College, Woolwich—The Assistant Commandant, Artillery College, Red Barracks, Woolwich, S.E.18. An agricultural entomologist at the Kirton Agricultural Institute—The Principal, Kirton Agricultural Institute, nr. Boston, Lincs. A junior chemist, and a senior laboratory assistant, under the Lancashire and Cheshire Coal Research Association—The Director of Research, Lancashire and Cheshire Coal Research Association, College of Technology, Manchester.

Our Astronomical Column.

Discovery of a New Comet, 1927 *d*.—A telegram from Prof. Shapley, circulated by the I.A.U. Bureau at Copenhagen, announces the detection of the fourth comet of 1927. The discovery was made by Dr. C. L. Stearns, at the Van Vleck Observatory, Wesleyan University, Middletown, Connecticut, on Mar. 10 at 10^h $4{\cdot}8^m$ U.T. in R.A. 15^h 16^m $6{\cdot}0^s$, south declination, 7° 21′ 43″. The comet was of the tenth magnitude, and its daily motion was -16^s, North 19′. On Mar. 19 it will be in R.A. 15^h 13^m 42^s, south decl. 4° 53′, assuming uniform motion. This is some 5° north of β-Libræ. Meridian passage will be about 3^h 30^m A.M.

Radio Reception and Solar Activity.—A paper entitled "The Correlation of Radio Reception with Solar Activity and Terrestrial Magnetism" is contributed by G. W. Pickard in the *Proceedings of the Institute of Radio Engineers*, Feb. 1927. The purposes of the paper are to emphasise the need for prolonged systematic observations of radio reception and to give preliminary results which have been obtained from data extending over nine months. At the outset it appears that poor broadcast reception coincided with practically every magnetic disturbance of note between 1922 and 1926 as registered at Cheltenham, U.S.A.; but in order to establish a more definite correlation, a series of nightly measurements of the radio reception at Boston of WBBM at Chicago (operating at 1330 kilocycles) was commenced early in 1926. Over this relatively short interval the author obtains a correlation factor of $-0{\cdot}89 \pm 0{\cdot}06$ between radio reception and magnetic character on a monthly average basis. The graph for monthly averages show little correlation with sunspots, but on using moving weekly averages it appears that an increase of solar activity is paralleled by an increase in magnetic disturbance and a decrease in reception. Another graph, giving weekly departures from monthly means of sunspots, magnetic character of days, and radio reception, shows a succession of peaks suggestive of the well-known 27-day interval relation between solar disturbances and magnetic storms. Other points of interest are, first, that the low frequency end of the radio spectrum is not very sensitive to solar disturbances, the most sensitive portion being apparently between 1000 and 1500 kilocycles; secondly, that although the magnetic storm and reception depression begin together, the storm reaches its maximum before reception is at a minimum and magnetic quiescence returns two or three days before reception is normal. It is greatly to be hoped that the observations will be continued to substantiate thoroughly these interesting preliminary results.

Solar Eclipse of June 29.—The Ordnance Survey has published a very useful map of the circumstances of the total solar eclipse across England and Wales on June 29 (Southampton : Ordnance Survey, 1927. 3*s*.). The scale is ten miles to the inch. The central line, north and south limits of totality, the lines where the magnitudes are 0·99, 0·98, 0·97, 0·96, the lines where the sun's altitudes are 10°, 11°, 12°, 13°, and those where central eclipse occurs at U. T. 5^h 20^m, 5^h 21^m, etc., to 5^h 28^m, are all laid down from computations made at the Nautical Almanac Office. As estimated corrections have been applied to the moon's positions calculated from Brown's Tables, the various curves should be accurate within a mile. The map shows contour lines for every 400 feet of altitude, the spaces between them being printed in different colours; this information is of use in selecting stations, as the sun is so low in Wales that it is important to ascertain whether high ground will interfere with the view.

The width of the track of totality is 28 miles on the west coast and 31 miles on the east coast; the speed of the shadow is about 100 miles per minute.

It may be mentioned that two excursions to the eclipse from London are announced; one by Messrs. Cook to Southport, the other by the L.N.E.R. to some point in Yorkshire near the central line. The departure from London is on the afternoon or evening of June 28, returning on the following afternoon. These should be very useful to observers pressed for time.

Research Items.

The Savignano Statuette.—M. Raymond Vaufrey in T. 36, Nos. 5-6 of *L'Anthropologie*, discusses the possible dating of the female statuette in serpentine discovered at Savignano. in the province of Modena, northern Italy, some three years ago, and now in the Museum of Ethnography and Prehistory of Rome. The question is of some importance in relation to the occurrence of different phases of the palæolithic period in the Po valley; but in default of stratigraphic evidence, it depends entirely upon morphological considerations. The statuette is 225 mm. high, and, if it be of palæolithic age, is the largest of these figures yet discovered. Its material is presumably of local origin, as similar serpentine occurs in the neighbouring Appenines of Emilia. The superficial details of the sculpture are much worn. In form the statuette is an elongated ellipse with the arms pressed close against the body; the legs join, the oblique position of the line of division suggesting the action of walking; the feet are not indicated The head is a prolongation of the body without indication of a neck, and is pointed. the general appearance being as of a head-dress falling over the shoulders. The breasts, abdomen, and thighs are prominent but beautifully sculptured. The genitalia are not indicated. The statuette is markedly steatopygous. Italian archæologists are not in agreement as to its probable age, one school represented by M. P. Graziozi attributing it to the Aurignacian. while M. U. Antonielli considers it neolithic. The statuette, however. strikingly resembles those of Barma Grande. The position of the arms clasped on the breasts is characteristic of the palæolithic type, for in statuettes of later date the hands support the breasts Notwithstanding the absence hitherto of evidence of the Aurignacian in the Po valley, its occurrence on other sites in Italy supports the attribution to this period.

The Emeryville Shell Mound, California —An exceptional opportunity for examining the structure and composition of one of the many shell mounds, nearly four hundred in number, on the shores of the Bay of San Francisco. occurred in 1924, when it was decided that the Emeryville Mound, one of the highest, should be levelled to make room for a factory site. The use of the steam shovel made it possible to examine the whole of a horizon at one time, while further excavations could be made at the base when the whole mound had been removed. A report of the investigations carried on in these favourable conditions by Mr. W. Robert Schenck has been issued as No. 3 of Volume 23 of the *University of California Publications in American Archæology and Ethnology*. As a whole, the results go to show a general uniformity of culture, though there was a number of periods of occupation The primary purpose of the settlement was to gather shellfish. The occupation would appear to have been seasonal; but all the groups who used the site were not identical; indications of difference exist. The culture was simple and not of a high level. Fires and basketry were known from the beginning. Food was probably cooked in the baskets by means of hot stones. Snares, traps, and wooden weapons were used rather than the bow and arrow. Sea food, obtained by raft, acorns, seeds, and other vegetable foods, were in use. Fish were caught by hook and line and not by net. Warfare was apparently infrequent, as few of the skeletal remains show signs of death from violence. Shell ornaments and beads were used on pipes and whistles. mortars and clothes. The grave furniture varied in different cases, even in infant burials, some interments being accompanied by many articles. others by none. Special groups of subjects—*e g* whistles, pipes, and charmstones—suggest a certain specialisation of occupation and social position. Objects of a ceremonial nature—crystals and charmstones—indicate the existence of a cult. while the scarcity of pipes points to the ceremonial nature of smoking. Burial was by inhumation or, more rarely, by cremation, graves occurring in groups near the dwelling-places. Artefacts buried with the dead were 'killed.' A speculative dating places the beginnings of the mound at about a thousand years ago.

Technical Terms in Brewing and Malting.—A list of technical terms used in the brewing, malting, and allied trades has been compiled by S. K. Thorpe, and appears in a recent number of the *Journal of the Institute of Brewing*, 33, 15; 1927). The list, which is very comprehensive and includes even commercial terms connected with the industries, contains a number of interesting notes on the origin and history of the words described. Words which deal with brewing are mostly of Flemish or Dutch origin, whilst those connected with barley or malting are of Celtic or Anglo-Saxon origin. Most of the words have preserved their original meanings throughout the ages, though the term "maltster" was probably a female "malter," just as a "spinster" was a female "spinner." "Ale" also was originally the name applied to sweet unhopped wort and was not identical with "beer," which was made from a weaker wort boiled with hops or a herb such as gentian. The word "bridal" or bride-ale" indicates its original connexion with feasting. In more recent times a new set of terms has evolved, though "cocktail," which dates from the American War of Independence, is usually thought to be of later origin. "Punch" is the subject of interesting speculation, since although derived from the Hindustani word "panch," meaning five (the number of ingredients), it is older than the British occupation of India, and may have come to western Europe via the Near East.

Scottish Salmon.—In a report on the salmon of the River Dee (Aberdeenshire) in 1923 (*Fisheries, Scotland, Salmon Fish.*, 1926, 4 (Sept. 1926)) Mr W. J. M. Menzies and Mr. P. R. C. Macfarlane confirm results obtained from examinations made in the two previous years. 1921 and 1922. A total of 1968 salmon and 833 grilse were examined. and information obtained on age. length, and condition is given, together with calculated lengths at the end of each year of life, as shown by scale readings. The 1 + and 2 winter groups have been the mainstay of the Dee salmon population during these years, the only other group of any importance being the 2 + group. February to April are exclusively spring fish months. May is characterised by a mixture of spring and summer salmon, and fish that seem to be in a transition stage between the two, these last being an obstacle to the theory that spring and summer salmon are of separate races. Previous evidence that fish which have already spawned return to fresh water for their second spawning in the same 'class' as on the first visit is confirmed. The majority of smolts at migration were two years old, although in 1922 the three-years-old smolts were rather plentiful. There is a distinct correlation between lengths attained each year: *e.g.*, large one-year parr become large two-year smolt, while small one-year parr become small second-year smolt, or remain in the river to become third-year smolt. This correlation is continued even in sea life.

ZOOLOGICAL EXPLORATION IN SIBERIA.—A special expedition of the Russian Academy of Science was working during the summer of 1926 in the Far East collecting insects and studying their distribution. More than 30,000 insects have been brought back by the expedition, and a preliminary study of the material, published in the *Information Bulletin* of the Academy, showed a large percentage of undescribed forms of all orders. A very striking feature of the collections is a very considerable number of species which have been previously known only from Japan and China. Of special interest is a giant longicorn beetle *Callipogon relictus* Sem., a representative of the fauna of relict Tertiary forests which is known only by a few specimens. A member of the expedition, Prof. A. K. Mordvilko, studied specially the Aphidæ (plant-lice), of which 215 species have been collected, many of them new, others known previously from Japan or China, while most of the European species are represented by special local races. Another small expedition of the Academy was studying at the same time the water fauna of Ussuri-land and of Lake Baikal. Special attention was paid to some less-known and little-collected groups of invertebrates, particularly to the Turbellaria. Of these, 40 fresh-water species have been found, 17 of them new to science, while nearly all of the 26 species collected in the Japanese Sea near the shores proved to be undescribed. A highly peculiar fauna of Turbellaria was found in Lake Baikal, where not less than 26 endemic species were discovered, some of them representing new genera and even new families.

THE MICROPLANKTON OF CHESAPEAKE BAY.—A very large amount of material has been collected for the quantitative study of the microplankton of Chesapeake Bay ("An Investigation of the Microplankton of Chesapeake Bay." By J. J. Wolfe and Bert Cunningham, with the assistance of N. F. Wilkinson and J. T. Barnes. *Journal of the Elisha Mitchell Scientific Society*, vol. 42, Nos. 1 and 2, Oct. 1926), which has been worked out by Mr. J. J. Wolfe and Mr. B. Cunningham. The samples were obtained by means of a water bottle and centrifuged, the volume of deposit measured, and portions of such deposit diluted and recentrifuged for counting. The investigations show that the Bay is by no means short of microscopic organisms, the average total for all collections distributed over two years being about 75,000 per litre, the largest collection being more than three million per litre. When one considers that a very large number of minute cells were probably not seen, judging from the lists given, this shows it is not at all poor. The authors are of the opinion that the most important factor in the growth and increase of the diatoms is temperature, the range in the Bay being from 30° F. to 76° F., the optimum temperature for diatoms being between 46° F. and 55° F. On the other hand, the protozoa, including dinoflagellates, are at their lowest at these temperatures and highest when the diatoms are low. Taking the total number of organisms throughout the year, there are two maxima, one in spring and one in autumn. These are usually due to diatoms, but high up in the Bay in autumn in two areas the cause is the dinoflagellate Prorocentrum, and these are the regions of low salinity. The spring maxima are almost always caused by diatoms, the largest numbers being due to Chætoceros, Skeletonema and Rhizosolenia also being very common. The voluminous mass of data relating to the above studies is filed with the Bureau of Fisheries, where it will be valuable for future reference when more investigations with regard to available fish food are undertaken.

CILIATED PROTOZOA AND CONTRACTILITY.—In a communication made to the Royal Lombardy Institute of Science and Letters, Prof. Antonio Pensa describes his observations on ciliates of the genus Balantidium, found as parasites in the intestine of the frog. These organisms prove capable of motion independently of the cilia, more especially when progress with the help of the cilia is retarded by the conditions of the surrounding medium. Such secondary movement results from contractility of the plasma and may be superposed on the principal effect due to vibration of the cilia so as to exert a modifying influence. The contractility is manifested mainly by the appearance of furrows, which may be either partly or completely annular. These furrows originate at the anterior part of the animal and undergo gradual backward displacement, the more fluid portion of the endoplasm apparently flowing at the same time in the opposite direction. The contractile wave stops when it reaches the posterior extremity of the animal, which then moves with a slight leap. If the furrow is circular, complete, and perpendicular to the axis of the body, the displacement is directly forward, but with a complete and inclined furrow it is perpendicular to the plane of the furrow and hence oblique and lateral; lateral motion towards the side occupied by the furrow occurs when this is partial and lateral. Another characteristic form of contraction consists in a rapid and circumscribed retraction of the posterior pole of the protozoon; this phenomenon is often almost rhythmic and effects arrest of the progress caused by ciliary vibration. Localised retraction of the posterior pole may determine a slight backward impulse. There seems little doubt that these contractions are proper to the endoplasm and are due to a peculiarity of structure or constitution which may be rendered evident by the application of silver reduction methods.

COAST AND GEODETIC SURVEY IN THE UNITED STATES.—The report of the United States Coast and Geodetic Survey for the year ending June 30, 1926, has been issued. In addition to revision of coast surveys in the United States, progress was made in those of oversea possessions. Coast surveys of the Philippines are almost complete except for the north-east coast of Luzon and parts of Palawan and of the Sulu archipelago. In the Hawaiian Islands there are still some gaps in the hydrographic survey and a few in the coast topographic survey. Work on the approaches to the Panama Canal and on the waters and coasts of the Virgin Islands and Porto Rico is practically finished. Good progress was also made in Alaska. Work was continued in the readjustment of the first-order triangulation to the westward of the ninety-eighth meridian in the United States, and there is the usual record of magnetic and tidal work. A matter of some interest in the report is a statement regarding the redetermination, this time by radio time signals, of the old longitude station at Seattle, Wash. A comparison between the old and the new determination showed a difference of only 0·003 second. The report contains a large number of index maps showing the present state of coastal surveys in American territory.

FOSSIL PERMIAN INSECTS FROM EUROPEAN RUSSIA. —While there is a considerable number of records of fossil Permian insects from North America, practically nothing was known of them in Europe. It is therefore interesting to learn from the *Information*

Bulletin of the Russian Academy of Sciences that Dr A. V. Martynov was fortunate enough to discover and collect a good series of these fossils on the shores of the river Kama, in northern European Russia. Best represented in the collection are Homoptera and Mecoptera; then there are some highly interesting Protorthoptera, also Neuroptera, Psocoptera, and others. A preliminary study of the collection permits one to conclude that the fauna was somewhat similar to the Permian fauna of Kansas, but not identical with it, since not only genera, but even families, were different though related to those of Kansas. More extensive and detailed investigations are proposed during the next season.

X-Ray Spectroscopy.—The issues of the *Physikalische Zeitschrift* for Jan. 1 and 15 contain a report of 70 pages by Dr. A. E. Lindh on the development of Röntgen or X-ray spectroscopy during the years 1921-1925. It comprises the following subjects: Apparatus—tubes and spectrographs—the development of technique, the gratings, the deviation from the simple law $n\lambda = 2d \, . \sin \theta$, refraction and total reflection, emission spectra, the K, L, M, and N series, absorption of the K, L, and M series, the conditions for the production of the various lines, the measurement of their intensities, their energy levels, the influence of chemical structure on spectra, the Compton effect, and the β-ray spectra. The report, which devotes 10 pages to the literature of the subject, will prove of great value to those working in this field.

Measuring Zonal Aberrations.—Part 1 of Volume 28 of the *Transactions of the Optical Society* contains an account of the method of determining the foci of the various zones of an optical system invented by Mr. Conrad Beck and communicated to the Society on Nov. 11 last. An accurately centred metal disc has two short slits cut in it with their centres at opposite extremities of a diameter of the zone to be investigated, and with their directions making with the diameter an isosceles triangle with basal angles 45°. The width of each slit is about one-third the length. Light from a fine hole in a silvered glass surface placed in the axis of the system is allowed to pass through the slits to the system, by which it is brought to a focus. The exact position of the focus is determined by the fact that at the focus the diffracted images of the slits form a symmetrical cross. By the use of discs with the slits at different distances apart, the focus for each zone and the zonal aberration may be determined.

Concentration of Water Vapour in Compressed Gases.—An important paper on the concentration of water vapour in compressed hydrogen, nitrogen, and mixtures of these gases in the presence of condensed water has been published by E. P. Bartlett in the *Journal of the American Chemical Society* for January 1927. The water vapour content depends on the nature of the saturated compressed gases, and the values calculated from the ordinary gas laws differ considerably from those actually observed. Thus, volume for volume, at 1000 atmospheres and 50°, nitrogen will hold 44 per cent. more water vapour than will hydrogen, and the water-vapour contents are much larger than the theoretical. No thermodynamical relations have been found that will connect the observed and calculated results. The phenomena are explained qualitatively by assuming that the compressed gas is a solvent for water vapour.

Frequencies Employed in Speech and Music.—In the *Bell Laboratories Record* for February, an account is given of phonograph records that have been made to demonstrate the effects of excluding notes of definite pitch from speech and music. The research was made by the American Telegraph and Telephone Company with the object of improving telephony. Electrical 'filters' were employed which could suppress sounds of a given range of frequencies. The frequency of the vibrations occurring in speech vary from about 100 to 8000 cycles per second. The effect of cutting out all the vibrations below 375 per second is to alter the character of the voice, although the intelligibility remains perfect. When all sounds having a frequency less than 750 were eliminated, the voice sounded most unnatural and had no character. The vowel sounds were badly distorted, but the speech could be interpreted mainly through the consonant sounds. When all the lower vibrations are restored but those having frequencies greater than 2500 are suppressed, the voice sounds natural but the interpretation is not good. When all the vibrations above 1000 are suppressed, the speaker's voice has a guttural character, and it is very difficult to understand what he says. Whole phrases are sometimes missed, owing apparently to the absence of consonant sounds. Another record shows similar effects produced in transmitted music when sounds of certain frequencies are suppressed. When the filter passes only the frequencies above 375 the melody is present but the tonal character is missing. When all sounds below 750 are suppressed, the music assumes a tinkling character. When the higher notes above 2500 are eliminated the music becomes dull, all the brilliance of tone disappearing. If all the notes above 1250 are eliminated the music becomes practically a thumping noise. Another record shows the effects of forcing a vacuum tube to carry more than its rated load. In this case harsh extraneous sounds called 'buzzing' and 'rattling' are introduced.

Philosophy and Physics.—The greatest workers in mathematics and physics have always been philosophers as well. A complete insight into these subjects is impossible without philosophy. In "Het Nut van het Wijsgeerig Denken in Wis-en Natuurkunde," Dr J. H. Tummers deals in an interesting manner with the benefit to be derived by mathematicians and physicists from philosophical thinking. While the whole of the contents of the brochure may not receive universal acceptance, it can be read with profit by all. In developing his thesis, Dr. Tummers sketches the history of the ether from the beginnings of the wave theory of light up to the Michelson-Morley experiment. The failure of the latter to show us the ether recalls to mind Planck's axiom, "Only that which can be measured exists." Einstein, contemplating the experiment in this light, has shown us how to do without the ether. This aspect of the theory of relativity and the changes which the latter has brought about in our ideas of space and time are next considered. It is emphasised that we must look inside the mathematical superstructure and find out what are the philosophical bases of the theory—what is contained in and implied by the differential equations. Before dealing with the ideas of space and time of the theory of relativity, Dr. Tummers sketches the philosophical and mathematical bases of the various geometries which have been proposed. He discusses the idea of the geodesic and shows how the geometries of Riemann and Lobattschewski are equivalent to ordinary Euclidean geometry on the surface of a sphere and on a Beltrami surface respectively. These geometries stand on an equal footing as regards their being 'true.' Einstein has not shown that space is non-Euclidean, but that the phenomena of Nature can be more conveniently represented by a non-Euclidean concept of space.

Forthcoming Books of Science.

Agriculture, Forestry, and Horticulture.

George Allen and Unwin, Ltd.—The Physiological Basis of Drought-Resistance in Plants, N. A. Maximow. Translated from the Russian, edited by Prof. R. H. Yapp; The Evolution of the English Farm, M. E. Seebohm. *Cambridge University Press.*—The Physiology of Reproduction in the Cow, J. Hammond; The Economics of Small Holdings, E. Thomas. *Chapman and Hall, Ltd.*—Teaching Agricultural Vocations, Stewart and Getman. *John Murray.*—A Primer of Agricultural Economics, Sir Henry Rew. *Oliver and Boyd.*—The Potato, P. M'Intosh. *Kegan Paul and Co., Ltd.*—Year Book of Agricultural Co-operation in the British Empire, with a Census of Producers' Organisations, edited by the Horace Plunkett Foundation. *Charles Scribner's Sons.*—The Beginner's Garden, Mrs. F. King.

Anthropology and Archæology.

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Wind Drift.

A STRONG wind at sea has long been known to cause a drift of the upper layers of water superimposed upon the regular and periodic tidal currents. Sailing coastwise in clear weather, the navigator can determine the position of his vessel by bearings on landmarks, but in thick weather he can no longer do this, and it then becomes a matter of importance to know the velocity and direction of the currents, both tidal and wind-blown, to which his vessel may be subject. In sailing and slow-moving ships, seamen have need to make a rough allowance for this wind drift, in addition to the leeway made by the vessel, when calculating their position by dead reckoning in bad weather. The necessary allowance has never been more than a guess, usually on the assumption that the wind-blown current runs in the direction of the wind, simply augmenting or decreasing the normal speed of the tidal currents.

The early theory due to Zoppritz was based on a consideration of the internal friction of sea-water in regular motion, and took no account of either eddy motion in the water or the effect of the rotation of the earth upon the wind-driven current; it fitted in with the general experience of seamen, but did not accord with later observations of the drift of the ***Fram*** in the polar ice, during 1893–95, when the ice drifted some 28° to the right of the wind's direction and proceeded on the average at 2 per cent. of the wind's velocity. A mathematical consideration of the forces due to the tangential pressure of the wind on the surface and the rotation of the earth acting upon particles of water in motion led Ekman to conclude that, unless constrained by land or shallow depths, the surface water would move 45° to the right of the wind's direction throughout the northern hemisphere and at greater angles with decreasing velocity at greater depths. Observations of the upper 10 cm. to 60 cm. of water at a number of Finnish and Swedish light vessels in the Baltic showed a movement some 19° to the right of the direction of the wind. The speed was nearly twice as great when the wind blew in the same direction as the coast line, than when blowing directly on shore or off shore. The average speed of the current varied, not directly with the wind's velocity as occurred with the polar ice, but with its square root.

A number of other estimates of the relation between the velocity of this surface drift and of the wind have been made, but they show no general agreement; a few observations suggest that this deviation from the direction of the wind increases with depth, as would be expected from Ekman's conclusions, but the depth to which these currents extend in varying circumstances is unknown. This facet of the subject is one of some practical interest in fishery research; for example, the young of herring born in the English Channel are carried by such a current into the North Sea.

The need for accurate knowledge of the wind drift as well as the tidal currents along the Pacific coast of the United States, where harbours are many miles apart, sailing courses long and periods of thick weather not infrequent. has led the U.S. Coast and Geodetic Survey[1] to collect and analyse numerous current data from five light vessels. After allowing for the calculated tidal current the residual drift, almost entirely due to wind, was obtained for several thousand observations. These were made by means of a pole 15 ft. long, weighted at one end and floating 1 ft. out of the water'; no allowance is made for the pressure of wind on the exposed part of the pole.

The velocity of the wind drift set up by winds varying between 10 miles and 60 miles an hour was approximately 2 per cent. of the velocity of the wind, being slightly under this value for high winds. This is a similar relation to that found by Nansen for the polar ice, but an entirely different relation from that found by Whitting for the surface 10 cm. to 60 cm. in the Baltic. The latter also holds for the surface 15 cm. in the English Channel and North Sea, as deduced from the drift of bottles so weighted that only about 3 c.c. of the cork end floats above water.

The direction of the wind drift along the Pacific coast averaged 23° to the right of the wind's direction, except for winds from the south-west sector, in which case the coast line trending north and south constrained the current to move north, 24° to the left of the wind's direction.

The observations recorded by the U.S. Coast and Geodetic Survey are a definite addition to the data available, and have in consequence a wider interest than that of the purpose for which they were primarily made.

H. W. H.

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[1] U S Coast and Geodetic Survey Special Publication, No. 121, pp. 80. Coastal Currents along the Pacific Coast of the United States. By H A. Marmer. (Washington, 1926)

The Japanese Earthquake of Mar. 7, 1927.

FOR the second time since the great earthquake of Sept. 1, 1923, Japan has been visited by a destructive earthquake. The Tajima earthquake of May 23, 1925, was followed on Mar. 7 at 6.28 P.M. (or 9 28 A.M. G.M.T.) by another in nearly the same district, but probably some miles to the east. According to the official report issued from Tokyo, the central zone covers the counties of Naka and Yosa in the province of Tango. It is also stated that the roads to the north of Maizuru are impassable owing to the deep fissures caused by the earthquake. Thus, the centre must be close to the west coast of Wakasa Bay on the Japan Sea side of the islands.

In the small towns of Mineyama, Iwataki, Kaetu, Amino, Kayamachi, Ishida, and Yamada, containing from two to four or five thousand inhabitants, most of the houses are demolished or destroyed by the fires that broke out afterwards. As these, however, are not industrial centres, the purely economic effects of the earthquake will not be serious. The great towns of Osaka, Kyoto, and Kobe, to the south of the earthquake-zone, though strongly shaken, have suffered but little damage. The total number of lives lost is reported to be 2459.

The name of the province of Tango appears but seldom in Sekiya's catalogue of Japanese earthquakes. About fifty miles to the south, however, lies the important seismic district of Kyoto, and about the same distance to the east and south-east are the provinces of Mino and Owari, in which occurred one of Japan's greatest earthquakes, that of Oct. 28, 1891, with its remarkable fault-displacements.

Though their results in the loss of life and the destruction of property have been serious, both the earthquake of 1925 and that of Mar. 7 last are typical examples of the earthquakes that occur on the Japan Sea side of the islands. The late Prof. Omori divided the destructive earthquakes of Japan into two classes, local and non-local, according as they affected one province or several provinces. From the fifth century to near the close of the nineteenth century there were 221 destructive earthquakes in Japan. On the Japan Sea side of the islands there have been scarcely any but local shocks, while the Pacific side has often been shaken by great non-local earthquakes.

C. DAVISON.

University and Educational Intelligence.

CAMBRIDGE.—S. Goldstein, St. John's College, and W. V. D. Hodge, St. John's College, have been awarded Smith's Prizes for essays on "Mathieu Functions" and "Linear Systems of Plane Algebraic Curves of any *Genus*," respectively. D. Burnett, Clare College, and C. A. Meredith, Trinity College, have been awarded Rayleigh Prizes for essays on "Electric Radiation over the Earth's Surface," and "Some Theorems on Infinite Cardinals," respectively.

The General Board of the Faculties has recommended that the Disney professorship of archæology shall be brought under the new statutes for election, tenure, and duties; that its stipend be raised from the endowment to £1200 a year; that it shall be assigned to the Faculty of Archæology and Anthropology, and that the field within which the professor shall give instruction shall be classical, medieval, and prehistoric antiquities and fine arts.

It is proposed to appoint Mr. H. Quinney as an assistant in experimental research in the engineering department.

APPLICATIONS for grants in aid of scientific investigations bearing on agriculture, to be carried out in England and Wales during the academic year beginning on Oct. 1 next, must be made to the Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1, by May 15 next. The Ministry is offering not more than seven research scholarships in agricultural and veterinary science, each tenable for three years, applications for which must be made not later than June 30 next; it also invites applications for not more than five agricultural scholarships tenable for two years. The latest date for the receipt of applications is June 30.

A PAPER on "University Government with special reference to the University of London" was read by Mr. T. Ll. Humberstone at the Education Guild on Mar. 9, Sir Richard Gregory presiding. After describing the origins and constitutions of the archetypal universities, Bologna and Paris, the university of students and the university of masters respectively, he pointed out that Oxford and Cambridge were modelled on Paris, and remained true to type as autonomous societies of masters. These universities have handed down from the Middle Ages a tradition of a self-governing community with full freedom of opinion as precious as their dreamy spires and moonlit lawns. Referring to the proposed new constitution of the University of London, he emphasised the importance of ensuring a high standard of attendance in the Council. Convocation representation on the Senate should bring the University into touch with the world of affairs, the professions, and industries. Mr. Humberstone is opposed to any extension of institutional representation on the Senate, considering that college principals should be selected and appointed on grounds of personal merit. The Principal of the University should be a member of the Council and of the Senate *ex officio*, as there is no warrant in the constitutional history of universities for the exclusion of a high officer from membership of the governing body. He urged that special attention should be given to methods of voting. There is need for greater publicity as to the work and aspirations of the University. The chairman agreed that the question of the status of the Principal should receive attention, and strongly supported the plea for greater publicity; support of the University would be more generous if the needs of the University were explained.

Calendar of Discovery and Invention.

March 20, 1800.—It was in his letter addressed "a Como en Milanois, ce 20 m Mars 1800," that Volta communicated to Sir Joseph Banks his discovery of the voltaic pile. The letter arrived in parts, but the whole was read to the Royal Society on June 26, 1800. From the information contained in the first part, Nicholson and Carlisle made a pile with 36 half-crowns and 36 zinc discs, and with this they decomposed water.

March 20, 1877.—Fifty years ago, on Mar. 20, 1877, in his presidential address to the Iron and Steel Institute, Sir William Siemens directed attention to the possibility of utilising the power of Niagara Falls for driving dynamos and for transmitting electricity over long distances for lighting and smelting. Thirteen years later the Niagara Commission, including Kelvin, Mascart, Sellers, Turretini, and Unwin, was appointed; in 1893 a contract was placed with Westinghouse, and in 1895 three 5000-h.p. machines were started. To-day more than half a million horse-power is developed by the various plants.

March 21, 1816.—The Royal Academy of Sciences of Paris was founded by Colbert in 1666. During the Revolution, in 1793, all the academies were suppressed, but two years later the National Institute was founded. With the Restoration, further changes were made, and on Mar. 21, 1816, the academies were placed on their original footing. It was at this time also the names of Carnot and Monge were removed because in 1792 they had voted for the death of the king.

March 22, 1792.—A notable improvement in rapid communication resulted from the invention of the semaphore by Claude Chappe, which he laid before the Legislative Assembly of France on Mar. 22, 1792. During trials a message was sent from the Louvre to Lisle, 48 leagues distant, in thirteen minutes. The semaphore was extensively used during the Napoleonic Wars, and up to 1849 the Admiralty maintained a chain of semaphore stations at Chelsea, Putney, Kingston, Esher, Cobham, Guildford, Godalming, Haslemere, Midhurst, Petersfield, and Portsdown. Chappe's monument stands in the Boulevard Saint Germain.

March 24, 1787.—On Mar. 24, 1787, Dalton made his first entry in a book entitled "Observations of the Weather, etc." During the course of the next fifty-seven years he entered some 200,000 observations in this journal, the last being made the evening before his death.

March 25, 1655.—To-day Saturn is known to have ten satellites. The first discovered and the largest, Titan, was seen by Huygens on Mar. 25, 1655. Between 1671 and 1684, Cassini discovered four more; Herschel added two in 1789, Bond and Lassell found Hyperion in 1848, while Pickering discovered the other two in 1898 and 1904 respectively. Phœbe, which was found in 1898, has a motion in the opposite direction to the other nine.

March 26, 1762.—In 1713 an Act of Parliament authorised the award of sums of £10,000, £15,000, and £20,000 for determining the longitude at sea within 60, 40, and 30 miles respectively. Many astronomers and mechanicians assisted in the solution of the problem, but the principal work was done by John Harrison, the inventor of the marine chronometer. His seagoing timepieces were made in 1735, 1739, 1749, and 1759, and it was with the fourth that his son made a voyage from Portsmouth to Jamaica and back, the voyage lasting from Nov. 18, 1761, to Mar. 26, 1762. During this time the error only amounted to 1 min. 54¼ sec.

E. C. S.

Societies and Academies.

London.

Royal Society, Mar. 10.—**A. Levin** and **J. Wyman**: The viscous elastic properties of muscle. 'Viscosity' is a term used to denote irreversible processes which cause a loss of work, greater with greater speeds, and prevent the muscle from contracting instantaneously. A mechanical model consisting of two elastic elements (springs), of which one only is damped, will imitate muscular effects, and it is argued that the muscle is mechanically a system of this type. When the muscle is stimulated isometrically, tension is shared by the damped elastic and free elastic elements. When the muscle is then released at a constant rate, the damped elements lag behind, causing thereby a drop of tension, which, however, is not instantaneous, owing to the presence of the free elastic elements. As the shortening proceeds, a steady state of lag is reached exponentially. When the release stops, the damped elements continue to shorten, stretching the free elements, and the tension redevelops exponentially. In a stretch the events occur in the opposite order. The actual contractile structures are the damped elements. The free elastic elements act as 'buffers.'

F. W. R. Brambell and **A. S. Parkes**: Changes in the ovary of the mouse following exposure to X-rays. 75 per cent. of the animals killed upwards of five weeks after irradiation, when adult, were sterilised. No hiatus occurred in the œstrous cycles following irradiation. The elements already forming the cortex at the time of irradiation persist and constitute the tissues of the sterilised ovary. They are derived from the embryonic germinal epithelium and produce œstrin in the normal ovary; they continue to do so without interruption after irradiation. 'Anovular' follicles were formed from the smaller follicles, by the degeneration of the oocytes and the growth of the membrana granulosa cells, immediately after irradiation.

A. S. Parkes, **Una Fielding**, and **F. W. R. Brambell**: Ovarian regeneration in the mouse after complete double ovariotomy. Of 121 double ovariotomised mice, all of which showed initial cessation of the œstrous cycle, eleven afterwards showed signs of spontaneous œstrus. In eight of these eleven cases the presence of new ovarian tissue was demonstrated histologically. The exact site of regeneration could not be ascertained. In most cases follicles and corpora lutea were found in the regenerate tissue, and generally these cyclic structures could be correlated with the recent œstrous history of the animal. Most of the regenerate animals had a normal cycle after the first spontaneous appearance of œstrous symptoms, but in at least one case a very irregular series of œstrous-like phenomena occurred, prolonged cornification being the chief feature observed.

A. Walton: The relation between 'density' of sperm-suspension and fertility as determined by artificial insemination of rabbits. Experiments on artificial insemination of rabbits show that fertility is influenced by the density or number of spermatozoa introduced into the vagina of the female. Fertility is reduced where the estimated number of spermatozoa is less than about 10^6 per 3 c.c. Sterility occurs where the number is below 10^4 per 3 c.c. Three factors probably play a part in determining the results, but are not subject to separate quantitative estimation:—(*a*) The probability of any one spermatozoon reaching the fertilisable ovum is small; (*b*) the spermatozoa are not all capable of fertilisation; (*c*) toxicity may act differentially on sperm-suspensions of varying density.

Alexander Hynd: The action of glucosone on normal animals (mice) and its possible significance in metabolism. The subcutaneous injection of glucosone, a first oxidation product of glucose, in appropriate dosage, produces in normal mice a condition very similar to that caused by insulin, the symptoms being modified or inhibited by an injection of either adrenaline or pituitrin. The 'glucosone effect,' however, is not remedied by the administration of glucose. An injection of acetoacetic acid antagonises the effect of a glucosone injection, indicating that glucosone may be of significance in fat metabolism. Glucosone is, perhaps, formed by the action of insulin on blood sugar, and thus may be an important compound in the intermediate metabolism of carbohydrates.

Cambridge.

Philosophical Society, Jan. 31.—**Sir Joseph Larmor**: What determines the resistance and tilt of an aeroplane? Formulæ were given by J. J. Thomson in 1883, in which the six components of the resultant momentum in an unlimited field of fluid motion were expressed in terms of the distribution of vortical spin alone. When they are extended, in intrinsic invariant form, so as to apply to regions of a field of motion produced by solid bodies, passive or propelled, they ought to provide a formal foundation, possibly of technical value, on which to base the general dynamics of propulsion of an aeroplane or airship. Applications are made, for example, to the necessity for opposite nearly compensating vorticities in the wake: also, the relation to the current procedure which derives the supporting force from a definite smooth circulation of the air around the body: also, and historically, the nature of the process by which mainly a system of vortices is thrown off from a travelling solid body, which only later degrades into tumultuous disturbance.—**L. H. Thomas**: The effect of the orbital velocity of the electrons in heavy atoms on their stopping of α-particles. 'Collisions' between α-particles and electrons are divided into two classes; close collisions, which may be treated as if the electron were free, and slight collisions, which may be treated as small disturbances of the electron. For swift α-particles the two classes overlap. The second type of collisions is neglected altogether and the first type arbitrarily delimited as those for which the transfer of energy is larger than the ionisation potential (Henderson's assumption). For swift particles and heavy atoms the error so introduced is comparatively small. On the average a particle loses more energy to a moving electron than to a stationary one.—**F. H. Constable**: Surface adsorption and the velocity of chemical action at gas-solid interfaces. The formula previously deduced connecting the partial pressure of the reactant in a mixture with the fractional reaction velocity has been verified for mixtures of alcohol vapour diluted with water, acetone, and benzene; and for the composition of the adsorbed film on platinum exposed to mixtures of carbon monoxide and oxygen. The effect of the mixture of vapours on the temperature coefficient of reaction is considered. If the heat of desorption of the reactant is greater than that of the diluent, then the temperature coefficient is diminished; if they are equal, there is no alteration; and if less, the temperature coefficient is increased. Water present as a diluent in alcohol has little effect on the temperature coefficient of the reaction.—**H. D. Ursell**: The evaluation of Gibbs' phase integral for imperfect gases. The phase integral for a perfect gas (neglecting the factor corresponding to impulse co-ordinates) is V^N. It has sometimes been assumed that in general the value is $V^N(1+g)$ where g is of the order of the imperfection. This, however, is not correct, the form taken being actually $V^{N}e^{N\prime}$, and this fact invalidates any simple discussion of an imperfect gas. An exact expression is obtained for the phase integral in the form of a multiple series, from which different equations are written down which equally define it. When these have been expressed in terms of g it is possible to approximate, and thus to evaluate g, and hence the pressure, to any order for a given molecular model.

MANCHESTER.

Literary and Philosophical Society, Feb. 8.—**Wilfred Irwin**: The presence and distribution of salt in the air, rain, and rivers of this country. Samples were taken at twelve different stations in England simultaneously, each sample representing three months' rainfall at those stations. This was done during a stormy winter quarter, and again during a calm spring quarter. In the stormy period the content of the salt may vary from 199 parts per million at Maryport on the sea coast in Cumberland, to 5¼ parts at Ryton on Dunsmore in Warwickshire, and in the mild period from 32 parts at Maryport to 5 parts at Ryton. In urban areas, chlorides are emitted along with smoke and the results are very irregular. Lakes in the Lake District were tested for salt; with the exception of Derwentwater and Bassenthwaite, which are influenced by the saline spring at Brandlehow, results show that Loweswater, the gathering ground of which is nearest to the sea, contains the most salt—16 parts per million—and that Haweswater, the farthest from the sea, has the least—only 8 parts. The salinity of the rainwater over England and Wales probably averages about 7 to 8 parts per million, and the average rainfall, 35 inches. This means that about one million tons of solid salt are annually carried in spray from the sea to the land, to be returned by the rivers to the sea. It is calculated that to bring the land in Warwickshire to the same salinity as that in the neighbourhood of Cockermouth, one hundredweight of salt per acre would be required to be added.

Feb. 22.—**D. C. Henry**: Some recent advances in colloid theory. Experiments recently made at the Cambridge Low Temperature Research Station on the freezing of gelatin gels throw some light on the constitution of such gels. In one series, measurements were made of the velocity with which the crystallisation of water is propagated through a supercooled gel when 'seeded' with a small particle of ice. Whereas a 1 per cent. gel does not greatly hinder the crystallisation process, a 2 per cent. gel reduces the crystallisation velocity to less than a tenth of its value in water, except in the immediate neighbourhood of the isoelectric point. In this neighbourhood the gel is turbid instead of clear, and it is probable that opaque fibrils are formed at the expense of the main structure of the gel, which is thus weakened sufficiently for the ice to break through without much hindrance. A second series of experiments has established the existence of a reproducible equilibrium between ice and gel of a definite concentration, varying with the temperature, and leads to definite conclusions as to the proportion of the water in a gelatin gel which may be considered as 'bound' to the gelatin.

PARIS.

Academy of Sciences, Feb. 7.—**P. Villard**: The chemical actions of radiations. Remarks on a recent note of A. Gargam de Moncetz.—**E. Mathias**: Contribution to the study of fulminating material. The decomposition of a certain kind of globular lightning, spontaneous and without sensible noise.—**Charles Jordan**: A generalised case of the probability of repeated trials.—**Paul Alexandroff**: A definition of Betti's numbers for any closed ensemble.—**E. Lainé**: The method of Darboux and Moutard's equations.—**P. Lejay**: The synchronisation at a distance of precision pendulums without use of any contact. A method is described which would appear to be applicable in other directions also. A small heterodyne short wave emitter is placed in the same room as the pendulum. To the condenser of the oscillating circuit which fixes the wave-length, a 20 cm. wire is connected and arranged so that the pendulum in oscillating passes some millimetres from its free extremity. The resulting variation of capacity of the wire with respect to the pendulum causes a sufficient variation of the wave-length to produce a record in the ordinary way. The notches produced on the record are perfectly symmetrical and have a base of 0·02 sec.—**Nicolas de Kolossowsky**: The specific heats of a sufficiently cooled non-condensed phase.—**Pierre Jolibois** and **Pierre Montagne**: A graphical method of calculation of the energy yield of homogeneous reactions.—**Paul Riou** and **Paul Cartier**: The influence of some organic substances on the velocity of absorption of carbon dioxide by solutions of neutral sodium carbonate. The viscosities of the sodium carbonate solutions were increased by addition of glycerol, dextrose, and saccharose. Tabulated results are given shewing the velocities of gas absorption per square centimetre of absorbing surface and the corresponding viscosities.—**A. Boutaric** and **Mlle. M. Dupin**: The existence of two zones of instability in the flocculation of ferric hydroxide sols by electrolytes with polyvalent cations.—**Eugène Fouard**: A general method of preparation of metallic colloids. The method requires a colloid (starch, gelatine, albumen) completely freed from associated metallic salts, and an electrical method for carrying out this purification is described. In an aqueous solution of such a purified colloid a metallic salt is dissolved, and this is electrolysed between two insoluble electrodes with a current of a few milliamperes. A colloidal solution of the metal is formed round the cathode. The method has been successfully applied to a large number of metals, including mercury, lead, bismuth, copper, and antimony, and also to arsenic, iodine, and tellurium.—**G. Denigès**: A new method for the volumetric estimation of molybdenum. The method is based on the reduction to Mo_3O_8 by aluminium foil in sulphuric acid solution, followed by titration with permanganate.—**Max** and **Michel Polonovski**: A new method for the transformation of the tertiary heterocyclic bases into secondary dealkylated bases.—**Clément Duval**: A cobaltiboroammine. The preparation of a new ammine is described: analysis showed it to be $CoBO_3(NH_3)_3$. It is insoluble in water and very stable.—**A. Wahl** and **G. Vermeylen**: A new transposition in the naphthylamine sulphonic acids.—**L. Eblé**: The periodic deviations from the vertical at Paris. An analysis of the results obtained with the horizontal pendulum at the Paris Observatory over a period of 31 months.—**V. Vincent**: The measurement of the ionimetric acidity by the inversion of saccharose. Application to complex media: sols.—**C. Motas**: Hydracarus of the genus Megapus in the Dauphiné Alps.—**A. Labriet** and **R. Husson**: Experimental analysis and synthesis explaining the passages of the singing voice in the theory of vocal accord.—**A. Mordvilko**: The biology of the Phylloxera of the vine. The conditions of its subterranean life. The influence of climate.—**Marcel Abeloos**: The speed of regeneration of the head in *Planaria gonocephala*. The influence of the level of the sections.—**P. E. Pinoy** and **A. Nanta**: The frequent existence of a mycosis of the spleen in Algeria. The pseudo-cysts causing enlarged spleen in Algeria are due to a fungus similar to *Sterigmatocystis nidulans*, cultures of which have been obtained. The fungus penetrating the spleen introduces bacteria causing a secondary infection, and it is possible that the nature of the associated bacteria may modify the clinical type of the disease.

Vienna.

Academy of Sciences, Jan. 13.—**O. Wettstein**: Five new European mammals, species of Pitymys from Croatia and Tyrol.—**L. Walmann**: Report on the geological survey of the Moravian primitive rocks in Lower Austria.—**H. Leng**: Adsorption experiments on glasses and filtration materials by the methods of radio-active indicators. Adsorption on glasses approaches saturation.—**M. Holly**: (1) A new subspecies of silurid from Kamerun; (2) a new species of cyprinid from the islands of Little Sunda.—**L. Kober**: The geology of the Salzkammergut.—**A. Tauber**: Integration of linear differential equations.

Jan. 20.—**F. Wessely** and **M. John**: Researches on a-amino-N-carbonic acid anhydride.—**K. Przibram**: The coloration of compressed rock-salt under Becquerel radiation.

Official Publications Received.

British.

County Borough of Halifax. First Annual Report of the Corporation Museums for the Year 1925–6. Pp. 15+2 plates. (Halifax.) 2d.

British Museum (Natural History) Picture Postcards. Set E45: Exotic Moths, Series No. 10. 5 cards in colour. 1s. Set E46: Exotic Moths, Series No. 11. 5 cards in colour. 1s. Set E47: Exotic Moths, Series No. 12. 5 cards in colour. 1s. Set E48: Exotic Moths, Series No. 13. 5 cards in colour. 1s. (London.)

Committee of the Privy Council for Medical Research. Report of the Medical Research Council for the Year 1925–1926. Pp. 161. (London: H.M. Stationery Office.) 3s. 6d. net.

Leeds University. Twenty-second Report, 1925–26. Pp. 184. (Leeds.)

Report of the Botanical Survey of India for 1925–26. Pp. 9. (Calcutta.)

Board of Education. Regulations for Whitworth Scholarships, 1928. Pp. 15. 2d. net. Syllabus of the Science Scholarships Examination, 1928. Pp. 23. 4d. net. (London: H.M. Stationery Office.)

The Carnegie Trust for the Universities of Scotland. Twenty-fifth Annual Report (for the Year 1925–26) submitted by the Executive Committee to the Trustees on 9th February 1927. Pp. iv+79. (Edinburgh.)

Melbourne Observatory. Hourly Values of the Magnetic Elements at Toolangi, in 1924. Observed and reduced under the Direction of Dr. J. M. Baldwin. Pp. ix+87. (Melbourne: H. J. Green.)

Union of South Africa: Department of Agriculture. 11th and 12th Reports of the Director of Veterinary Education and Research. Part 1, September 1926. Pp. 817. (Pretoria: Government Printing and Stationery Office.) 10s.

Aeronautical Research Committee: Reports and Memoranda. No. 1047 (Ae. 233): Model Tests on a Combined Slot and Aileron Control on a Wing of R.A.F. 15 Section. Push Forward Type of Auxiliary. By F. B. Bradfield and A. S. Hartshorn. (A.2.a. Stability Calculations and Model Experiments, 112—T. 2291.) Pp. 10+8 plates. 9d. net. (London: H.M. Stationery Office.)

Foreign.

Cornell University Agricultural Experiment Station, New York. Bulletin 450: Results of Sweet-Corn Suckering Experiments. By H. C. Thompson. Pp. 15. Bulletin 451: The Relative Efficiency of some Copper Dusts and Sprays in the Control of Potato Diseases and Insect Pests. By Oran Cecil Boyd. Pp. 63. Bulletin 452: Economic Studies of Dairy Farming in New York. vi: Grade B Milk with Cash Crops and Mixed Hay Roughage, Crop Year 1922. By E. G. Misner. Pp. 56. Bulletin 454: The Spruce Gall-Aphid. By Glenn W. Herrick and T. Tanaka. Pp. 17. Memoir 98: The Collection and Utilisation of Pollen by the Honeybee. By Ralph L. Parker. Pp. 55. Memoir 99: The Nitrogen and Carbohydrate Composition of the Developing Flowers and Young Fruits of the Apple. By Freeman Smith Howlett. Pp. 79. Memoir 103: The Growth of certain Micro-organisms in Planted and in Unplanted Soil. By J. K. Wilson and T. L. Lyon. Pp. 25. (Ithaca N.Y.)

Field Museum of Natural History. Botanical Series, Vol. 6, No. 1: Citrus Products. Part 1. By James B. McNair. (Publication 238.) Pp. xi+212+7 plates. Zoological Series, Vol. 12, No. 12: The Amphibians and Reptiles of Mona Island, West Indies. By Karl P. Schmidt. (Publication 236.) Pp. 147-162. Zoological Series, Vol. 12, No. 13: Amphibians and Reptiles of James Simpson-Roosevelt Asiatic Expedition. By Karl P. Schmidt. (Publication 237.) Pp. 165-173. Zoological Series, Vol. 16: Catalogue of the Edward E. Ayer Ornithological Library. By John Todd Zimmer. Part 1. (Publication 239.) Pp. x+364+8 plates. Part 2. (Publication 240.) Pp. 365-706+plates 9-12. (Chicago, Ill.)

Department of Commerce: U.S. Coast and Geodetic Survey. Terrestrial Magnetism. Serial No. 360: Magnetic Declination in the United States in 1925. By Daniel L. Hazard. (Special Publication No. 126.) Pp. 33+1 map. (Washington, D.C.: Government Printing Office.) 10 cents.

U.S. Department of Agriculture: Weather Bureau. Monthly Weather Review, Supplement No. 27: Montezuma Pyrheliometry. By C. G. Abbot. (W.B. No. 906.) Pp. 15. (Washington, D.C.: Government Printing Office.) 20 cents.

Observatoire de Zi-ka-wei. Annales de l'Observatoire astronomique de Zô-sè (Chine). Tome 14, Fascicule 2: Observations du soleil (taches et protubérances), 1923, 1924, 1925. Pp. A61-A120. (Zi-ka-wei.)

Bulletin of the American Mathematical Society. List of Officers and Members, 1925-1926. (Supplement to Vol. 32, No. 5, September-October 1926.) Pp. 60. (Menasha, Wis., and New York.)

Diary of Societies.

SATURDAY, March 19.

British Mycological Society (London Meeting) (in Botanical Department, University College), at 11 a.m.—W. R. I. Cook: Influence of Environment on Infection by *Ligniera Junci*.—E. H. Ellis: Fungi in Japanese Carvings.—E. W. Fenton: Seed Mixtures and the Incidence of Fungal Diseases.—Miss M. P. Hall: Zoning in Cultures of *Monilia fructigena*.—K. R. Mohendra: Varieties in *Sphaeropsis malorum*.—J. Ramsbottom: Fragmenta Mycologica VII.

Geologists' Association (in Department of Anatomy, University College), at 2.30.—Prof. G. Elliot Smith: Demonstration of Fossil Remains of Man.

Association of Mining Electrical Engineers (North of England Branch), at 3.—C. D. le Maistre: Standardisation of Colliery Electrical Requisites.

Physiological Society (at University College) (Annual General Meeting), at 3.—K. H. Coward and Dr J. H. Burn: Variations in Response of Different Rats and Mice to Injections of Oestrin.—A. W. Bourne and Dr. J. H. Burn: (*a*) The Dosage of Pituitary Extract in Labour; (*b*) The Value in Labour of the Different Constituents of Ergot.—I. de Burgh Daly: Blood Flow during Respiration: The Influence of the Heart and of the Lungs.—Prof. J. Mellanby: The Preparation of Fibrinogen and Fibrin Ferment from Oxalated Ox Blood.—Grace Briscoe: Graded Muscular Contractions of Natural Form Produced by Electrical Stimulation.—F. R. Winton: The Action of Squill Extracts on Rats.—I. T. Zeckwer: The Hyperglycæmic Response to Bacterial Vaccines.—Dr. F. W. R. Brambell: The Maturation of the Graafian Follicle in relation to Oestrus.—Dr. E. B. Verney: Some Acute Effects of Pituitary Removal in the Dog.—E. Ponder: The Reflex Act of Blinking.—W. P. Blount: The Blinking Reflex in Animals.—A. C. Hampson and M. Maizels: The Effect of *p*H on the Distribution of Phosphorus between Human Red Cells and Potassium Phosphate Solutions.—Demonstrations:—An Apparatus for Propelling Air round Small Enclosed Circuits when Leakage to CO_2 is to be Entirely Avoided, by F. M. Haines.—(*a*) Ovarian, Uterine, and Vaginal Changes during the Oestrous Cycle of the Mouse; (*b*) X-ray Sterilisation of the Mouse Ovary, by Drs. A. S. Parkes and F. W. R. Brambell.—The Respiratory Quotient of the Heart, by L. E. Bayliss, E. A. Muller, and Prof. E. H. Starling.—The Oxygen Usage of the Kidney, by A. Fee, A. Hemingway, and Prof. E. H. Starling.—A Stimulating Chamber for Plain Muscle, by F. R. Winton.—A Colorimetric Method for Roughly Controlling the CO Tension in Respiratory Gases, by L. M. Pickford and Dr. E. B. Verney.—(*a*) An Apparatus for Continuous Reading of E.M.F.; (*b*) A Photo-electrolytic Effect, by Dr. D. T. Harris.—An Improved Perimeter, by B. Lang.—The Histological Appearances of the Pituitary after Different Amounts of Insulin, by Elizabeth C. Eaves.

Royal Institution of Great Britain, at 3.—Sir Ernest Rutherford: The Alpha Rays and their Application to Atomic Structure.

MONDAY, March 21.

Victoria Institute at Central Buildings, Westminster), at 4.30.—Rev. A. H. Finn: The Predictive Element in Holy Scripture.

Royal College of Surgeons of England, at 5.—Dr. A. Piney: Hyperplasia and Neoplasia in Lymphatic Tissue.

Institution of Electrical Engineers (Informal Meeting), at 7.—R. J. Mitchell and others: Discussion on Domestic Electrical Refrigeration.

Institution of Electrical Engineers (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.

Institution of Electrical Engineers (Tees-Side Sub-Centre) (at Cleveland Technical Institute, Middlesbrough), at 7.

Institution of Automobile Engineers (Glasgow Centre) (at Royal Technical College, Glasgow), at 7.30.—H. R. Ricardo: Some Notes on Petrol-Engine Development.

Railway Club (at 25 Tothill Street, S.W.), at 7.30.—W. N. R. J. Back: The late History of the Great Northern Railway.

Aristotelian Society (at University of London Club), at 8.—G. Cator and C. E. M. Joad: Error (Symposium).

Royal Society of Arts, at 8.—G. I. Finch: Some Applications of Electrothermics (Cantor Lectures) (V).

Royal Geographical Society (at Æolian Hall), at 8.30.—J. M. Wordie: The Cambridge Expedition to East Greenland.

Chemical Industry Club.

TUESDAY, March 22.

Manchester Literary and Philosophical Society, at 4.—Prof. J. Barcroft: Physiology of Life in the High Andes (Wilde Memorial Lecture).

Royal Dublin Society (at Ball's Bridge, Dublin), at 4.15.—L. B. Smyth: On the Index Fossil of the Cleistopora Zone.—Miss Dorothy Beckett: The Influence of Separation and Pasteurisation on the Size of Fat Globules.—Exhibition by Dr. H. H. Poole of a convenient method of Charging Electroscopes.

Royal Society of Medicine (Medicine, Diseases in Children, and Dermatology Sections), at 5.—Dr. S. E. Dore, J. H. Sequeira, Dr. A. Eidinow, and others: Special Joint Discussion: The Uses and Limitations of Ultra-violet Light Therapy.

Royal College of Physicians of London, at 5.—Sir Charlton Briscoe: The Muscular Mechanism of Respiration and its Disorders (Lumleian Lectures) (1).

Royal Institution of Great Britain, at 5.15.—Dr. G. Shearer: X-rays and the Chemical Molecule (2).

Institution of Petroleum Technologists (Annual General Meeting) (at Royal Society of Arts), at 5.30

Zoological Society of London, at 5.30.—Secretary: Report on the Additions to the Society's Menagerie during the month of February 1927.—G. C. Robson: Seasonal and Sexual Dimorphism in the Squid *Alloteuthis subulata*.—Daphne Atkins: Report on the Myzostomida collected by Mr. F. A. Potts in Torres Strait, together with a Description of a Species obtained by Prof. J. Stanley Gardiner from the Maldives.—Oldfield Thomas: On Mammals from the Gobabis District of Eastern Damaraland, South-west Africa, obtained during Capt. Shortridge's Fourth Percy Sladen and Kaffrarian Museum Expedition. With Field-notes by the Collector.—Dr. F. P. Stowell and V. P. Clancey: Microscopical and Bacteriological Investigation of the Water in the Society's Aquarium.

Institution of Civil Engineers, at 6.—Prof. W. E. Dalby: Heat Transmission and the Motor-Car Radiator.

Institution of Aeronautical Engineers (at 30 Victoria Street), at 6.30.—L. A. Wingfield: Aircraft Law

Illuminating Engineering Society (at Lighting Service Bureau, 15 Savoy Street, W.C.), at 6.30.—L. M. Tye, W. Millner, H. H. Long, C. A. Hughes, and others: Discussion on Various Problems in Illumination and Practical Solutions.

Institution of Electrical Engineers (East Midland Sub-Centre) (at Derby Technical College), at 6.45.—G. H. Lake: Powdered Fuel.

Society of Chemical Industry (South Wales Section) (Annual Meeting) (at Technical College, Cardiff), at 7.

Institution of Electrical Engineers (North-Western Centre) (at Engineers' Club, Manchester), at 7.—Col. E. Mercier: Notes on the 60,000-Volt Underground Network of the Union d'Electricité.

Institution of Electrical Engineers (North Midland Centre) (at Hotel Metropole, Leeds), at 7.

Institute of Metals (Birmingham Local Section) (jointly with Birmingham Metallurgical Society and Staffordshire Iron and Steel Institute) (at Engineers' Club, Birmingham), at 7.—W. T. Griffiths: Nickel-Iron and Related Alloys.

Royal Photographic Society of Great Britain (Scientific and Technical Group) (Annual General Meeting), at 7.—Dr. O. C. de C. Ellis: Flame.

Society of Chemical Industry (Birmingham and Midland Section) (at Birmingham University), at 7.15.—D. W. Parkes: The Removal and Recovery of Phenols from Ammonia Sulphate Still Effluents.

Royal Anthropological Institute, at 8.30.—I. Schapera: Native Chieftainship in South Africa.

WEDNESDAY, March 23.

Royal Society of Medicine (Psychiatry Section) (Pathological Meeting in Laboratory of Maudsley Hospital, Denmark Hill), at 4.30.

Geological Society of London, at 5.30.—E. S. Cobbold: The Stratigraphy and Geological Structure of the Cambrian Area of Comley (Shropshire)

Institution of Automobile Engineers (Manchester Centre) (at Engineers' Club, Manchester), at 7.—H. R. Ricardo: Some Notes on Petrol-Engine Development.

Electrical Association for Women (at E.L.M.A. Lighting Service Bureau, Strand), at 7.—Electric Power Appliances in the Home.

Royal Society of Arts, at 8.—C. S. Orwin: The Transition of Agriculture.

Eugenics Society (at Royal Society), at 8.30.—Dr. C. C. Hurst: The Mechanism of Heredity and Evolution.

British Psychological Society (Medical Section) (at 1 Wimpole Street).

THURSDAY, March 24.

Chemical Society (Annual General Meeting), at 4.—Prof. H. Brereton Baker: Experiments on Molecular Complexity (Presidential Address).—Presentation of the Longstaff Medal for 1927 to Prof. R. Robinson, and of the Harrison Memorial Prize for 1926 to Dr. C. R. Harington.

Royal Society, at 4.30.—Sybil Cooper, D. E. Denny-Brown, and Prof. C. S. Sherrington: Interaction between Ipsilateral Spinal Reflexes acting on the Flexor Muscles of the Hind-limb.—Dr. F. W. R. Brambell: The Development and Morphology of the Gonads of the Mouse. Part I. The Morphogenesis of the Indifferent Gonad and of the Ovary.—Dr. R. J. Ludford: The Golgi Apparatus in the Cells of Tissue Cultures.—C. E. Walker and Margaret Allen: The Nature of Golgi Bodies and other Cytoplasmic Structures appearing in Fixed Material.—Dr. W. S. Patton and E. Hindle: The Development of Chinese *Leishmania* in *Phlebotomus Major* var. *Chinensis* and *P. Sergenti*. var.—G. S. Sansom: The Giant Cells in the Placenta of the Rabbit.

Royal College of Physicians of London, at 5.—Sir Charlton Briscoe: The Muscular Mechanism of Respiration and its Disorders (Lumleian Lectures) (2).

Royal Institution of Great Britain, at 5.15.—J. Guild: Colour Measurement and Standardisation (2).

Royal Aeronautical Society (at Royal Society of Arts), at 6.30.—Major M. Wronsky: German Commercial Air Development.

South London Entomological and Natural History Society, at 7.

Institute of Chemistry (Edinburgh and East of Scotland Section, jointly with same Section of Society of Chemical Industry) (at North British Station Hotel, Edinburgh), at 8.—A. M. Cameron: Fire Risks in Industry.

FRIDAY, March 25.

Physical Society of London (at Imperial College of Science), at 5.—Dr. E. Mallett: Acoustical Experiments with a Mechanical Vibrator.—Dr. E. T. Paris: The Stationary Wave Method of Measuring Sound Absorption at Normal Incidence.—J. H. Awbery and Dr. Ezer Griffiths: A Ball and Tube Flowmeter suitable for Pressure Circuits.—Demonstration of the Astrolabe and some other Medieval Surveying and Navigational Instruments, by Dr. A. Ferguson.

Institution of Mechanical Engineers (jointly with Society of Chemical Industry, Chemical Engineering Group), at 5.15.—Dr. W. R. Ormandy: Lubrication.

North-East Coast Institution of Engineers and Shipbuilders (at Newcastle-upon-Tyne), at 6.—Sir Richard Glazebrook: Pure Science: the Service it has already rendered to Engineering, and a Review of Modern Developments and their Possible Future Application.

Society of Chemical Industry (Glasgow Section) (jointly with Institute of Chemistry, Glasgow Section) (at 36 Buchanan Street, Glasgow), at 6.30.

Royal Photographic Society of Great Britain, at 7.—H. J. Bedford: Pocket Cameras and what can be done with them.

Institution of Engineering Inspection (at Royal Society of Arts), at 7.30.—Major H. Myers: The Educative Influence of Aircraft Inspection.

Junior Institution of Engineers, at 7.30.—S. R. Broderick: Notes on the Construction and Plant of the New Filtered Water Installation for the Seville Waterworks Company.

Royal Institution of Great Britain, at 9.—Prof. C. T. R. Wilson: Thunderclouds.

Manchester Literary and Philosophical Society (Chemical Section).

SATURDAY, March 26.

Geologists' Association (at Museum of Practical Geology), at 2.30.—Demonstrations:—Fossil Plants from the Coal Measures, by Dr. R. Crookall.—Goniatite Zones of the Millstone Grit of Central Lancashire, by S. W. Hester.—Fossils from the Neighbourhood of Leighton Buzzard, by J. Pringle.

Royal Institution of Great Britain, at 3.—Sir Ernest Rutherford: The Alpha Rays and their Application to Atomic Structure (2).

North of England Institute of Mining and Mechanical Engineers (at Neville Hall, Newcastle-upon-Tyne), at 3.—R. White: The Ventilation of a Pyrites Mine, with special reference to Fire-fighting, Safety and Rescue-work.

PUBLIC LECTURES.

SATURDAY, March 19

Horniman Museum (Forest Hill), at 3.30.—H. N. Milligan: Animal Growth and Evolution.

SUNDAY, March 20.

Guildhouse (Eccleston Square), at 3.30.—Address on One of the World's Beliefs.

TUESDAY, March 22.

Bedford College for Women, at 5.15.—Prof. E. T. Whittaker: Present Conceptions of the Cosmos.

THURSDAY, March 24

Fulham Central Public Library, at 8.—W. H. Hempsall: The Wonders of the Bee-Hive.

SATURDAY, March 26.

Horniman Museum (Forest Hill), at 3.30.—M. A. Phillips: Wild Life in Meadow, Stream, and Wood.

SUNDAY, March 27.

Guildhouse (Eccleston Square), at 3.30.—Very Rev. Dr. J. H. Hertz (Chief Rabbi): Fundamental Ideals and Proclamations of Judaism.

CELEBRATION.

March 18 to 20.

Mathematical Association (Yorkshire Branch) (at Grantham).—The Two-Hundredth Anniversary of the Death of Sir Isaac Newton.

March 19, at 10 A.M.—Bicentenary Scientific Meeting in the Old School, King's School, Grantham, with addresses by:—

- Sir J. J. Thomson: Newton's Work in Physics.
- Sir F. Dyson: Newton's Work in Astronomy.
- Dr. H. Lamb: Newton's Work in Mechanics.
- Prof. G. H. Hardy: Newton's Work in Pure Mathematics.
- Dr. J. H. Jeans will preside and give an address on Isaac Newton.

At 2.—Pilgrimage to Woolsthorpe Manor House (Newton's birth-place) and visit to Stoke Rochford, where Mr. C. Turnor will speak on Newton's Countryside.—At 7.30.—Celebration Dinner at the George Hotel, Grantham. Chairman: Sir J. J. Thomson. Speakers: Prof. H. H. Turner, Prof. E. T. Whittaker, the Bishop of Birmingham, and the Bishop of Lincoln.

March 20, at 11.15 A.M.—Bicentenary Service at the Parish Church, Grantham. Preacher—The Bishop of Birmingham.

CONFERENCE.

Tuesday, March 22.

Rothamsted Experimental Station, Harpenden, at 11.30 A.M.—Conference on Cultivation: What the Farmer aims at and how he does it. Chairman: Lord Bledisloe.

- H. Drewitt: Cultivation on the West Sussex Chalk and Brick Earth.
- J. Joyce: Spring Cultivation in Western England.
- J. H. Spilman: Cultivation Operations on the Yorkshire Wolds
- J. Steel: Spring Cultivation in an Eastern County.
- Dr. B. A. Keen: Cultivation: The Art and the Science.

CONGRESSES.

April 20 to 24.

Journées Médicales Marseillaises et Coloniales (at Marseilles).—Prof. Cantacuzène: The Rôle of the Streptococcus in the Etiology of Scarlet Fever.—Dr. Mayer: Recent Advances in the Treatment of Cancer.—Prof. Ottolenghi: Malaria.—Dr. N. Bernard: Beri-beri.—Prof. Imbert: Bone-grafting.

April 25 to 28.

German Society for Internal Medicine (at Wiesbaden).—Discussions on Psychotherapy, introduced by Gaupp and Fleischmann; Results of Recent Functional Investigations of the Stomach and Duodenum, introduced by G. Katsch.—A joint meeting with the German Rontgen Society will be held on April 26, with a discussion on the Significance of Rontgen-ray Examination of the Lungs and Mediastinum for Internal Medicine (excluding Tuberculosis), introduced by Dietlen, Assmann, Haenisch and Lorey, and Fleischner.

SATURDAY, MARCH 26, 1927.

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Science and Human Life.

DISCUSSIONS centring round the application of scientific knowledge to the solution of social problems result too often in generalisations which have no regard to the very different positions in which the physical, biological, and social sciences find themselves to-day. It is a commonplace to say that if science is to be of use, research must be entirely unhampered. Generally speaking, there is nowadays freedom of research in all branches of science, though it can scarcely be supposed that, in countries such as Russia, social scientists are wholly free to investigate the institution of private property and the system of private enterprise.

The situation of the physical, biological, and social sciences is thus much the same so far as pure research is concerned. When, however, we come to consider the application of scientific knowledge, the situation is very different in each case. Where research continues unhampered there arise from time to time opportunities of employing the results of research, and our attitude towards these possibilities may be either scientific or unscientific. By a scientific attitude is meant the realisation that what research has disclosed is merely a method of producing with a greater or less degree of certainty a particular result. Methods themselves are neither good nor bad. Questions of value do not arise at this point, but only when we go on to consider the effect of the employment of these methods upon those persons who use or are in any way touched by the methods. Methods of mass production either do or do not result in greater productivity. This is a problem preliminary to and wholly separate from the question of the moral effect of mass production upon the workers.

So far as the physical sciences are concerned, we are no longer in the mood to regard aeroplanes as 'unnatural' or flying as 'impious.' Here the scientific attitude is in fact general. The social sciences stand at the opposite pole and there is as yet little sign of the emergence of the scientific attitude. Divorce, nationalisation, and capitalism are held to be good or bad in themselves; they may be worshipped or regarded as the evil one barely if at all disguised. The biological sciences occupy a midway position. Prof. Julian Huxley,[1] in his lecture on "Biology and Human Life" delivered before the British Science Guild on

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[1] Biology and Human Life. Norman Lockyer Lecture, 1926, by Prof. J. S. Huxley. (London: British Science Guild, 1926.) 1s

Nov. 22 last, discusses the use of the results of biological research in relation to health, quantity, and quality of population. The consideration of health raises the question of the use of vaccines, of the quantity of population that of contraceptive methods, of the quality of population that of controlled breeding.

No one at all well acquainted with popular discussions of these matters could claim that the scientific attitude is predominant. It is probably growing. It does not, however, seem to be more prominent in certain of the groups, social, religious, or political, into which the population is divided than in others. People regarded by others or regarding themselves as possessing 'advanced' views do not seem to be remarkable for their scientific outlook as defined here. A recognised leader of advanced political thought recently described inoculation as 'unclean.' This is equivalent to thinking that the taking of a census is a wicked act displeasing to Providence, and likely to be visited by an 'epidemical distemper,' as widely held in the eighteenth century. There are passages in Mr. H. G. Wells's "World of William Clissold" which suggest that he regarded birth control as an excellent thing in itself—precisely the same error the other way round.

Just as it cannot be said that people of certain religious views or of particular political opinions are more scientific than others in their attitude to the possible use of the results of research, so it does not appear that men of science as a whole are especially remarkable for their power of distinguishing between the efficiency of methods and the reactions upon moral conduct of the employment of the same methods. They are apt to think that because a method is effective it is therefore good.

This statement cannot, however, be made of Prof. Huxley. He does advocate, it is true, the use of contraceptive methods and the control of breeding, but he sees that he must justify his advocacy not merely by observing that problems of the quantity and quality of population present themselves which these methods might solve, but also by a demonstration, so far as it can be given, that the moral effects would be good. It does not seem, in fact, to be difficult to build up a case to show that few scientific methods have ever offered so much opportunity for the unselfish regard for the welfare of others as those which permit us to regulate numbers—which is a necessary precedent to a life of decency in any community—and to go some way at least towards ensuring that the next generation shall begin life reasonably well endowed with all that makes possible a full and useful existence.

It is thus of primary importance that if, as Prof. Huxley desires, use is to be made of our rapidly increasing biological knowledge, what has here been described as the scientific attitude towards the application of the results of research should become more widespread. It cannot be too strongly urged that those who press upon the public the use of contraceptive methods as admirable in themselves are just as reactionary as their opponents.

If we now leave this point and pass on to consider the knowledge available for dealing with the problems of quantity and quality of population, it is evident that we are better informed regarding methods of controlling quantity than of controlling quality. It is true that much remains to be done in the way of investigating the precise efficacy and incidental results of methods of controlling quantity. But the problem is of far less magnitude than that of quality. Progress can be made by independent research workers, which is by no means the case in some of the most important aspects of the quality problem.

If we are to have adequate methods of dealing with the quality problem, research must be prosecuted in four distinct fields. There is first the problem of the mechanism of heredity, and secondly that of the mode of inheritance of human character. These are problems which the independent investigator can attack. It is unnecessary to refer here to the amazing developments in our knowledge of the mechanism of heredity, which appears to be essentially of the same nature in all organisms. Progress in the second field is of necessity slow because of the impossibility of experiment. The research worker must make the best of such data as are available resulting from the uncontrolled matings of the human species. There is next the third field concerned with the distribution of inherited characters within the population, and the fourth concerned with the change in that distribution. We must know where certain qualities are to be found or, to put it in another way, how far social classes, occupational and economic groups, differ from one another now in respect to these inherited characters, and whether these differences are becoming greater or less.

Within these third and fourth fields the independent research worker is nearly powerless so far as the collection of data is concerned. A very little reflection will show that the efforts of independent research workers can never alone be expected satisfactorily to elucidate the position. It would be as reasonable to expect the unaided efforts of research workers in economics to obtain a satisfactory review of the trade or income of the country without recourse to government figures of imports, exports, and income tax, as to expect biologists by their own unaided efforts to give us at all full information as to the genetic composition of the population. It follows that adequate guidance cannot be given, even if the will to use it is there, unless government machinery can be set in motion to collect the data. If we have to wait for a government of this degree of enlightenment, a bleak prospect opens out. But encouragement may be obtained if we refer again to the economists. Income statistics are not collected because an enlightened government wishes to keep a watch upon the national income, but because a hard-pressed government has to find money. Economists have to use these data, inadequate as they are, for their own purposes.

There is similarly a possibility of the use by biologists of government data regarding the medical inspection of school children and of official data from the census, for the purpose of elucidating in some detail our biological heritage and the changes which are taking place. The difficulties at present are great, but government machinery exists which, if slightly adapted for this other purpose, would allow an examination to be made of the position and a watch to be kept of changes at least from decade to decade. The most urgent needs are that the medical examination of school children should be standardised in order that the data could be aggregated and the results of one year compared with those of another, and that the questions asked in the census of 1911, which rendered an inquiry into differential fertility possible, be made a permanent feature of the census. At the present time, we can do little more than guess what the position is.

The community must be brought to learn that there is no more fruitful use of communal resources than when applied to keeping a watch upon the biological inheritance of the community. It may or may not be desirable for us to copy Sweden, where a State Institute for Race-Biology has been founded for this purpose. But until ways of accumulating the necessary knowledge are found, we shall not be in a position to take effective steps, as Prof. Huxley desires, to "weed the garden of humanity."

A. M. C.-S.

Research in Historical Chemistry.

Studien zur Geschichte der Chemie. Festgabe Edmund O. v. Lippmann zum siebzigsten Geburtstage. Dargebracht aus nah und fern und im Auftrage der Deutschen Gesellschaft für Geschichte der Medizin und der Naturwissenschaften herausgegeben von Julius Ruska. Pp. vi + 242. (Berlin: Julius Springer, 1927.) 19·50 gold marks.

THE cause of research in historical chemistry owes much to the work and influence of two men: Marcelin Berthelot in France, and Edmund O. von Lippmann in Germany. It is an interesting coincidence that the approaching celebration, in October next, of the centenary of Berthelot's birth should follow so closely upon a public recognition of von Lippmann's activities in the common field of these two eminent chemists and chemical historians. At the recent jubilee of the Deutsche Gesellschaft für Geschichte der Medizin und der Naturwissenschaften, von Lippmann was awarded the Sudhoff medal for his researches in historical chemistry; the volume under review has now been issued under the auspices of the same society to mark the seventieth birthday of one whom Ruska acclaims in an eloquent dedication as "Meister und Führer" in this field.

It is to be remarked with regret that the volume contains neither a biographical notice of the doyen of chemical historians nor a discussion of his work and its influence on the progress of historical chemistry. Von Lippmann's industry and versatility may be gauged, however, from the accompanying list of 18 books and 159 original papers, etc., published by him since 1878. Among the more familiar book titles are "Geschichte des Zuckers," "Die Chemie der Zuckerarten," "Entstehung und Ausbreitung der Alchemie," and "Zeittafeln zur Geschichte der organischen Chemie"; while the papers contain historical references to such diverse subjects as sugar, the thermometer, aluminium, gunpowder, alchemical poetry, the Ebers papyrus, distillation, alcohol, Petrarch on alchemy, the use of petroleum in the Middle Ages, the name 'Berzelius,' chemistry and technology in Herodotus and in Dante, and so forth.

Apart from the items which have been mentioned, the book consists of a series of twenty-two essays by acknowledged authorities on subjects of special interest in historical chemistry. The contributions, which are arranged chronologically, touch upon the development of chemistry from the Babylonian era, through the Greek and Islamic periods, down to the present day. The collection conveys a striking impression of the vigorous growth of research in historical chemistry during recent years, particularly in Germany. Some of the papers attain a high level of scholarship, but it is not possible here to do more than comment upon a few points of outstanding importance or interest.

Darmstaedter (Munich), in a paper on the *lapis lazuli*, indicates that the great mythological significance of this stone in the Babylonian-Assyrian civilisation led to the production, by a carefully guarded process, of an artificial stone containing small quantities of copper and cobalt. Hopkins (Amherst, Mass.) endeavours to base a comprehensive explanation of early alchemical work upon a philosophy of colour, the trend of his argument being illustrated by such quotations as the following: "Cast a sulphur preparation upon silver to get gold" (pseudo-Democritus); "It is the tinctorial principle which causes the vapour to develop the gold" (Zosimus); "Mare tingerem si mercurius esset" (pseudo-Lully). It may be objected that colour was only one of many qualities, regarded in the Aristotelian sense as accidental, and that even the early alchemists knew gold when they encountered it. The sweeping claim that all alchemical practice was based upon an unvarying sequence of colours also invites criticism.

The most important contributions to this work are those dealing with Islamic chemistry. Wiedemann (Erlangen) directs attention to what is perhaps the first mention of magnetic polarity. Ibn 'Abd al-Raḥîm, quoted by Al-Jildakî, refers to a four-sided stone which was capable of attracting or repelling a certain piece of (magnetised) iron when presented to it in different ways. It may be noted that Petrus Peregrinus, of Picardy, made a similar observation in the thirteenth century.

The volume contains two contributions to the Jâbir (Geber) problem which are undoubtedly of first-class importance. It may be recalled that about two years ago Darmstaedter discovered a Latin version of Jâbir's "Book of Mercy"; Ruska (Heidelberg) now records the recent discovery in Egypt by Meyerhof of a large portion of the Arabic text of Jâbir's *Liber LXX.*, and gives a preliminary survey of the contents of this "unvergleichlich kostbaren Fund." For the second time within two years Latin and Arabic texts of Jâbir have been brought together, and such remarkable successes should encourage the enthusiastic band of investigators in this field to prosecute with redoubled ardour their search for the Arabic originals of the *Summa perfectionis* and other works of the central figure of Muslim chemistry.

"What Aristotle was for philosophers, Jâbir was for chemists," writes Holmyard (Bristol) in the sole British contribution to the volume under notice, "and a full investigation of his life and writings would unquestionably be of the utmost value for the history of chemistry." Holmyard now adduces important new evidence from Al-Dînawarî's Kitâbu'l-Akhbâr al-Ṭiwâl (Book of Lengthy Narratives), which, although handled with commendable restraint, will probably be accepted generally as providing a satisfactory settlement of the difficult questions of Jâbir's birth, parentage, nationality, and date. The evidence indicates that Jâbir was the son of a certain Arab Shî'ite known as 'Ḥayyân the druggist,' and that he was born at Ṭûs about A.D. 721–722, during his father's presence in Khurâsân on a political mission for the 'Abbâsids. A further elucidation of Jâbir's relations with the Barmakides and with Ja'far al-Ṣâdiq provides an apparently effective refutation of Ruska's contention that the Jâbir-Ja'far connexion was a myth. Students of this period will welcome the promised publication, by Geuthner of Paris, of a complete edition of Jâbir's Arabic works, accompanied by English translations.

Other articles deal with subjects of such general interest as chemical symbols (Walden, Rostock), Priestley's defence of the doctrine of phlogiston after his removal to America (Davis, Cambridge, Mass.), chemical instruction in the German universities in the first quarter of the nineteenth century (Lockemann, Berlin), and the Goethe-Wackenroder correspondence (Brauer, Cassel). The series concludes with an entertaining chemical potpourri by Speter (Wehlen). Those readers who are conversant with the efforts of William Barnes, the Dorset poet, to redistil the waters from 'the well of English undefiled,' will take particular interest in the suggestions for 'purified' German chemical terms; but though the puristic inorganic chemist might conceivably prefer "Sauerstoff" to "oxygen," his faith would need to be greater than a grain of mustard seed if it permitted him to accept for himself the designation "Nicht-Kohlenstoffverbindungsscheidekünstler"!

The book is well printed, and it contains an excellent frontispiece portrait of von Lippmann. It will be found both interesting and useful by all chemists who have developed that lamentably rare sense of historical continuity with the past which is so desirable in the teaching and study of science.

John Read.

Books and a Superlative.

The Best Books: a Reader's Guide to the Choice of the best available Books in every Department of Science, Art, and Literature, with the Dates of the first and last Editions, and the Price, Size, and Publisher's Name (both English and American) of each Book: a Contribution towards Systematic Bibliography. By William Swan Sonnenschein. With complete Authors and Subjects Index. Third edition, entirely rewritten. Part 4. Pp. 1681-2510. (London: George Routledge and Sons, Ltd., n.d.) 36*s*. net.

DESPITE any criticism of detail, this is a work indispensable to all persons for whom books are practical tools. This volume will have a special appeal to readers of NATURE; although it includes the classes of science, art, music, drama, domestic arts, and sports, three-quarters of the volume (which contains pp. 1681-2510 of the complete work) come under the heading of science.

Actually, however, this heading is used somewhat unscientifically, because it includes all industries and trades as well as the pure sciences. Also at first sight one is somewhat surprised to find here such headings as immortality, Christian science, industrial and economic history. The explanation is largely that the producers of the work have boldly faced the difficulty that the earlier volumes are tending to be out-of-date before the last volumes are completed.

As a corrective, wherever possible they have included 'additions' to the bibliographies of the subjects of the earlier volumes, and these 'additions' have been tacked on to more or less cognate subjects in the present volume, convenience being the controlling factor rather than a strict adherence to a scientific arrangement of topics.

This method has not been wholly disadvantageous. Besides affording probably the best means of bringing the earlier volumes up-to-date, it now gives us psychology in all its aspects as a branch of science. At its original place under philosophy its housing was somewhat old-fashioned; for psychology now passes from the speculative domains of philosophy into documented and precise methods of handling such as allow it to be regarded as a science proper.

We have tested the volume in some dozens of instances, and only exceptionally has it failed to produce the entry expected. One instance was "Population," by H. C. Wright, which was worth inclusion as a simple, clear, and inexpensive statement of the mildly-pessimistic attitude of the Cambridge school on the population question; another was "A Hillside View of Industrial History: a Study of Industrial Evolution in the Pennine Highlands," by A. Newell. This book, on account of its original investigations, was well worth inclusion in the 'additions' to industrial and economic history now given in this volume under arts and trades to supplement the treatment of the subject under earlier headings. The latter case, however, is not quite a fair test, because the book was published somewhat obscurely in Todmorden; although, in fact, it received favourable critiques through the usual channels. That a compilation should fail only in such points as this over a large number of tests, especially when allowance is made for differences of opinion as to what the 'best books' really are, shows the thoroughness with which the ground has been covered.

After all, however, the 'best book' is only best in relation to the purpose for which it is either intended or used. We are only half on our way towards selection when we get a list of 'best books' on a given topic, if that list includes all the best books without some attempt, if not at evaluation, at least at a comment on the point of view presented. Wright's book mentioned above is a good illustration. Some little evaluation is attempted in "The Best Books" by the use of an asterisk to indicate any work of outstanding importance. This mark of pre-eminence is, quite rightly, very sparingly used, and it is supplemented in a very small minority of examples by some brief evaluatory or explanatory comment. One would like to see the latter idea carried much further, but it would be a gigantic additional task to impose on the shoulders of the present compilers; this latest volume would probably have followed its predecessor at an interval of thirteen years instead of three years. In additional excuse, this work was a War casualty. The new edition was begun in 1910, the second volume appeared in 1912, the third in 1923, and now the fourth is published in 1926. But this latest volume shows a vitality unaffected by the passage of years, or by the happenings often inevitably associated with the production of a work over so long a period; for the ranks of its compilers have not been unaffected by the limitations of human mortality.

Such small additional points of criticism as occur would deal with the age of many books here noted and the consequent difficulty of obtaining them by purchase. Particularly is this the case in architecture, from which list one misses Aldin's "Old Manor Houses," but it is true that these books are nevertheless standard books.

This is a great work, unsurpassed in its scope or accuracy by any similar work in any other country. It now appeals almost pathetically for its index volume to make it fully usable, although there is an excellent system of cross-references between correlative topics. But could not some more straightforward notation be used than one which refers the inquirer to H § 47.* * * * * * ?

C. R. S.

Science and the Humanities.

Plant Nutrition and Crop Production. By E. J. Russell. Pp. ix+115+21 plates. (Berkeley: University of California Press; London: Cambridge University Press, 1926.) 12*s.* 6*d.* net.

In a recent review in these columns of a Stationery Office publication—"Research and the Land" (Dec. 4, 1926)—attention was directed to the dangers that research workers encounter when they enter the journalistic field, a danger picturesquely expressed in the Scots' proverb that —"fules and bairns shouldna see half-dune wark." The book before us (in part an excursion in that field) is the text of a series of lectures delivered at San Francisco under the provision of the Hitchcock Trust, of which the object and purpose appear to be publicity, not (we hasten to add) in the form of belauding any one person or institution, but with the dignified purpose of creating public confidence in scientific methods and ideals generally.

The task before the lecturer in this instance has been performed with great ability. We have here succinctly expressed a complete review of the whole history of scientific research on plant nutrition from the agricultural aspect, finishing up with some account of the more recent work on the subject at Rothamsted and elsewhere. The profuse and picturesque illustrations of this book, a selection, no doubt, from the lantern-slides displayed, are of unusual interest. From a literary point of view, too, the text is excellent. Few, if any, agricultural writers can surpass Sir John Russell in his shining enthusiasm for the humanistic value of scientific pursuits, the limitations of which never daunt him. "Exact knowledge," he says, "is the only sure basis for improvements: encourage, therefore, those among you who are striving to win it. Their task is slow, painful, and often disappointing . . . knowledge is but an approximation to a truth never to be wholly attained by man."

This, however, should be a review, not a panegyric; and one is bound to question whether enthusiasm based, as it may be, on personal achievement, may not obscure clear vision of the field as a whole as it appears to those primarily interested in the practical application of scientific results. What, for example, has the agronomist to say to all this? For it is upon *his* achievements that the popular support of scientific research in agriculture may depend, and, scientifically, are not the gaps in knowledge many and vital?

To the doubter, there can be only one answer. It may be true that half a century of agricultural research has not yielded an adequate harvest in the form of material return to the husbandman; but even the layman must hold to the faith that the only avenue to material improvement is increased knowledge. Long ago it was said . . . "*pater ipse colendi haud facilem esse viam voluit,*" and the way of the research worker is equally hard; but go the road, however hard it be, he must; if he fails to convert the common crowd to that faith, then, indeed, is the cause of applied science desperate. On this satisfying note our author aptly closes:

> . . . Man's the prerogative, knowledge once gained
> To ignore, find new knowledge to press for, to swerve
> In pursuit of, no! not for a moment: attained
> Why, onward through ignorance! Dare and deserve!
> As still to its asymptote speedeth the curve.

Our Bookshelf.

Matter and Gravity in Newton's Physical Philosophy: a Study in the Natural Philosophy of Newton's Time. By A. J. Snow. Pp. 256. (London: Oxford University Press, 1926.) 7*s.* 6*d.* net.

The explanatory title of this book, namely, "A Study in the Natural Philosophy of Newton's Time," gives a good indication of the scope and nature of the contents. It is certainly desirable in these days, when science, philosophy, and religion are all recognised as important contributors to the progress of human thought, to have such an outstanding period as that of the seventeenth century and early eighteenth surveyed, especially with reference to the atomic revival which, as the author points out, is very closely associated with the name of Pierre Gassendi. The work of Robert Boyle, and also the dispute between Gassendi's and Descartes' schools of atomism, are traced in the first chapter, and the question as to the divisibility of matter is shown to have formed an important phase of the intellectual background of Newton's time. Galileo's ideas with regard to movement are also traced, and so the way is prepared for the Newtonian atomism which is discussed in the second chapter.

The objections to Descartes are dealt with at length, and it is shown how that, to Newton, the idea of God was essential. The influence on Galileo is brought out in this chapter with regard to the theory of force.

In the third chapter, Newton's doctrine of gravity is treated, and throughout what follows, careful attention is paid to the question of action at a distance and ether. The controversy with Liebniz and the alleged 'occult powers' reveal the keen discussion in matters of natural philosophy which took place in the period under discussion. The 'active principles' of Newton receive careful treatment in this chapter, which closes with the mathematical theory of gravity.

The fourth chapter naturally deals with the metaphysical doctrine which Newton's theory suggests; attention is directed to the mystic influence of Jacob Boehme.

The last chapter discusses the relation of mathematics and physics to philosophy in general, and deals with the opposition which Newton's use of hypothesis met with in the polemic directed against him by the Cartesians. H. D. A.

Plato's American Republic. Done out of the Original by Douglas Woodruff. (To-day and To-morrow Series.) Pp. 122. (London: Kegan Paul and Co., Ltd.; New York: E. P. Dutton and Co., 1926.) 2*s.* 6*d.* net.

THIS delightful little book improves on a second reading. It is a mock Platonic dialogue—not pedantically close to the Greek—purporting to give Socrates' account of a lecture tour he has just taken in the United States, accompanied by Xantippe, who also lectures, with much more popular acceptance than her husband. The fun of the book runs fast, but is not furious. It is based on a subtle and penetrating but not unfriendly criticism of the prevalent mind in the United States. Much of it deals with familiar topics, Prohibition, card-indexes, the worship of numbers, facts and size, and, above all, of the new god 'Progress.' But it is all done more charmingly than we remember to have ever seen before, and it winds up with a companion picture of the mechanical and Philistine side of British civilisation. The remedy is to be found in the real education, on Greek lines, of young American women, who may be trusted afterwards to rule their husbands. The men are to be left for their own training to the discipline of football and baseball. The address of Socrates at the luncheon of the Rotarian Club in Hootsville is the gem of the book. He is finally shouted down when he urges that they "should do business" with the three weaving sisters of Greek mythology, Clotho, Lachesis, and Atropos with her dreaded shears. Did he not know, he was asked, that they in Hootsville, and everywhere else in the States, had machines which spun, measured, and cut thread in the single operation?

The concluding sentence of the book is typical of its combined seriousness and wit,—" For there are times when it is important to know the truth, and life is one of them." F. S. M.

Cement, Concrete and Bricks. By Alfred B. Searle. (Outlines of Industrial Chemistry.) Second edition. Pp. xi+441. (London: Constable and Co., Ltd., 1926.) 24*s.* net.

SOUND information about the materials named in the title of this book is badly wanted, and every effort to interpret the latest research work in a way which can be applied in practice should be welcomed. Mr. Searle in this new edition of his book directs attention to the work of Prof. Duff Abrams on the effect of the amount of mixing water in concrete. There is no doubt of the importance of this. The chapter on the chemistry of cements is much improved, but seems still rather overloaded with the work of W. and D. Asch.

There are, however, many statements in the book which are misleading. The description of a rotary kiln and the diagram on page 26 does not convey much impression of a modern plant. The statement on page 83 that the allowable limit of 2·75 per cent. for sulphur trioxide (SO_3) in Portland cement laid down by the British Engineering Standards Specification does not include the gypsum added to control the setting time, is incorrect. Again, the statement on page 111 that no standard specification for cements other than Portland has been issued by British Engineering Standards Association is incorrect. A standard specification for Portland Blastfurnace Cement was issued by this body in 1923 and revised in 1926.

The chapter on reinforced concrete is not helpful, and in many cases is misleading. It bears too much resemblance to a compilation from makers' catalogues. Much more work has been done on cement and concrete since the first edition of this book than has been noted in the revision, and it is regrettable that the work has not been brought up-to-date and the inaccuracies corrected.

Practical Hints to Scientific Travellers. Edited by Prof. H. A. Brouwer. Vol. 4. Pp. v+171+11 plates. (The Hague: Martinus Nijhoff, 1926.) 5 guilders.

A NOTICE of the first three volumes of this series appeared in NATURE, vol. 118, p. 44 (July 10, 1926); the fourth volume, now before us, deals with travel in Egypt, Angola, Australia, Antarctica, Venezuela, and Haiti. Doubtless the various articles are being published in the order in which they come to hand, but the result, in the case of the present volume, has been too miscellaneous a grouping. In any further edition of the whole work it would obviously be an improvement to redistribute the articles among the several volumes, in order to bring together those having some bearing on one another.

Like its predecessors, this volume is packed with useful and very much up-to-date information, although the sections on Venezuela and Haiti are short and scarcely enter into sufficient detail. In the section on Australia several pages are devoted to hints for botanical collecting, but most of the articles, being written by geologists, will probably be of especial help to members of geological expeditions. Prof. Griffith Taylor gives an interesting account of the experience gained by Capt. Scott's last antarctic expedition; his remarks should be very helpful when the preliminary arrangements are being made for any further expeditions to that part of the world. The illustrations in this book are well reproduced, and give a good idea of travelling conditions in the various regions.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

Biological Fact and Theory.

"*Who is this that darkeneth counsel by words without knowledge?*" (Job xxxviii. 2).

Prof. J. S. Huxley (Nature, Mar. 5, p. 350) writes: "Prof. Walker says . . . that Dobell 'proved' that hereditary characters could not be controlled by chromosomes in certain Protozoa." What I did say is quite different. Here it is: "There is a number of organisms in which the distribution of the chromosomes is such that they could not possibly convey a Mendelian character." I did not use the word 'proved,' which Prof. Huxley places in inverted commas, from beginning to end of my letter.

He goes on to say, "The main reason advanced by Dobell concerned sex," and "if Prof. Walker had been better acquainted with genetical literature he would have remembered that almost simultaneously with Dobell's 'proof,' Wettstein was demonstrating experimentally, and conclusively, . . ."

Mr. Clifford Dobell in the paper referred to, having given a detailed description of the distribution of the chromosomes in certain organisms, begins his argument as follows: "Let us now select a particular character and a particular chromosome, and consider their relations to one another. It is really immaterial which character or which chromosome we take; but for the sake of argument let us take sex as the character to be studied."

Any one reading the paper will find that it was written with the object of confronting with actual facts certain sweeping generalisations of which Prof. Huxley so constantly provides us with examples. He will also see that sex has nothing to do with the argument. So far as I can see, Wettstein's work on mosses, which Prof. Huxley quotes but to which he gives no reference, has no direct bearing on the particular point at issue, and I must place his use of it in the same category as his misquotation of me and his misunderstanding of Mr. Dobell.

Referring to Prof. Johnstone and myself, Prof. Huxley says, "But has Liverpool never heard of Boveri's experiments on disperm sea-urchin eggs, published exactly twenty years ago?" This work was published too late for me to refer to it in my little book on cytology (1907), but Prof. Huxley will find sufficient evidence to show that I had read it in my "Hereditary Characters" (1910, Edward Arnold, London, pp. 37-8 and 222).

I would bring a remarkably apposite passage from another work to his notice.

"Now, from the purely artistic point of view, . . . I consider it an axiom that one should never appear to doubt that the other side has performed the elementary duty of acquiring proper elementary information, unless there is demonstrative evidence to the contrary" (Thomas H. Huxley, "Collected Essays," vol. 5, p. 373. Macmillan, London, 1909).

As, however, the main object of all of us is the ascertainment of truth, I must ask to be forgiven for wasting so much space on trivial self-justification and return to my protest against the constant presentation of doubtful theories as proven facts. I have watched the development of 'neo-Mendelism' from its inception. (Having regard to Prof. Huxley's methods of controversy I must be precise. I do not mean from the time of the first publication by Mendel in 1865, but from the time of the 'rediscovery' very many years later.) I have watched, often with amazement, sometimes with amusement, assumption piled upon assumption as occasion arose to make the 'neo-Mendelian' 'laws' agree with the results of breeding experiments. The attitude of Prof. Huxley and others of the same school seems to me to approximate to that of the advertiser who is convinced that the more often he repeats a statement the greater will be the number of people who will believe it. Out of the vast accumulation of assumptions has arisen the jargon in which Prof. Huxley sets forth what he claims to be a statement of the fundamentals of genetics. This statement of fundamentals represents, not proven facts, but assumptions for which a varying amount of evidence is available. May I be allowed one final quotation:

> The meaning doesn't matter if it's only idle chatter of a
> transcendental kind,
> And every one will say
> As you walk your mystic way,
> "If this young man expresses himself in words too deep
> for me,
> Why, what a very singularly deep young man this deep
> young man must be!"

(W. S. Gilbert, "Patience," Opéra Comique, 1881.)

Charles Walker.

The University, Liverpool, Mar. 8.

In Nature of Feb. 26, Prof. Johnstone asks the question, "Is breeding cats, and cocks and hens, and flies, and so on, such fundamental research?" He might equally well ask, "Is reading galvanometers, or making organic compounds, or cutting sections, or stimulating nerves, such fundamental research?" The answer is quite clear. These operations, like breeding animals, are part of the technique of research, which may or may not be fundamental in any given case. For example, cat-breeding was part of a fundamental research when it showed that the spermatozoon determined the sex of the young, and that some of the differences between the wild species (or sub-species) of cat were inherited in a Mendelian manner.

After admitting his inability to understand the results which geneticists have so far reached, Prof. Johnstone then proceeds to tell them their real function, which is to determine how genes grow. Here I would very respectfully beg leave to differ from him. To-day the atomic theory in genetics is about as well established as was the atomic theory in chemistry a hundred years ago. But for a century after Dalton chemists concerned themselves not quite unprofitably with the mutual relations of atoms, without knowing very much about their nature. This is what geneticists are now doing with regard to genes; and just as the internal structure of atoms was elucidated by physicists rather than chemists, it is probable that the inner nature of the gene is a problem for the biochemist rather than the geneticist.

Prof. Johnstone's second fundamental problem, of how the genes co-operate in development, is analogous to the problem of how atoms co-operate in a molecule. The most obvious preliminary to its solution is to combine genes in as many different ways as possible and see what happens; and this is just what the despised breeders of cats are doing, to the extent of their financial resources. If they are better than Prof. Johnstone at solving crossword puzzles it may be that they share this superiority with organic chemists and spectrum analysts. So perhaps they need not be altogether ashamed of their little accomplishment.

J. B. S. HALDANE.

Trinity College,
Cambridge, Mar. 3.

I SHARE Prof. Johnstone's inability to solve either crossword puzzles or Mendelian results (NATURE, Feb. 26, p. 319). But I do not think this should encourage him to decry the carrying out of breeding experiments by men who can properly interpret them. It seems reasonable to regard Drosophila as the sum of a number of factors arranged in a certain way, just as a crystal of alum is an aggregate of molecules orientated in a definite pattern, of atoms specifically arranged to give molecules, and of electrons to give atoms.

It is almost an axiom of scientific method that analysis must precede synthesis. The first stage toward the solution of the Drosophila problem, then, must of necessity be one of analysis; the splitting up of the entity Drosophila into genes and factors. This analysis is far from being complete yet. With the materials gained thereby we can proceed to the synthesis, namely: Why is this aggregate Drosophila, and not Pulex or Homo? An attempt to synthesise before the materials are available is as ineffectual as the attempt to make bricks without straw.

The problem Prof. Johnstone propounds is, however, the really fundamental one; and until we reach the stage of synthesis, Drosophila will not be allowed to retire into the oblivion it so well deserves.

ERIC ASHBY.

Royal College of Science,
South Kensington, S.W.7.

Atmospheric Electricity.

DR. CHREE, in his review on the above subject (NATURE, Dec. 18, 1926, p. 894), has inadvertently drawn an erroneous inference with regard to the reduction factors used by Dr. Mauchly for the *Carnegie* potential-gradient observations. The manner of obtaining these factors is described by Messrs. Ault and Mauchly on pp. 207-209 of the volume (Researches, Department of Terrestrial Magnetism, vol. 5) reviewed, and it is stated by them that the values finally adopted depend on the reduction-factor determinations made during the years 1915 to 1921, namely, during cruises IV., V., and VI. (not VI. alone, as Dr. Chree infers).

Certain methods of reduction of the ocean observational data are criticised by Dr. Chree. The fact of the matter, however, is that there is no consensus of opinion as yet on the best methods for the reduction and derivation of so variable an element as the "atmospheric potential gradient." No agreement regarding these matters exists even at observatories in the same country and under the same general administration. He who wishes may readily find fault with the methods of his co-worker. So also as regards the application of "non-cyclic corrections" in the manner advocated by Dr. Chree, there is legitimate cause for difference of opinion. No adequate physical basis for Dr. Chree's assumptions has as yet been advanced.

But even had Dr. Mauchly omitted entirely the series of observations to which Dr. Chree takes exception, his general conclusion as regards the progression of the diurnal variation of the atmospheric potential gradient, according to universal time rather than local time, would not have been affected. Others have arrived at a similar conclusion. Thus, Dr. Hoffmann in 1923 (two years after Dr. Mauchly's first annoumcement in the *Physical Review*, vol. 18, pp. 162 and 477) concluded that the daily extreme values of the potential gradient at Arctic and Antarctic stations, as shown by the available series, occur everywhere at about the same absolute time (*Beiträge zur Physik der freien Atmosphäre*, xi, Heft 1, 1923).

Recent observations in Arctic regions and elsewhere have confirmed in the main the validity of the conclusions by Mauchly and Hoffmann. Thus, Dr. H. U. Sverdrup, in charge of the scientific work of Amundsen's *Maud* Expedition, recently reached the following conclusion from a discussion of all available observations on meteorologically undisturbed days: "Our observations in the Arctic sea, far from land or close to the coast near the 160th meridian of east longitude, give very positive confirmation of the conclusions by Mauchly and Hoffmann."

There are land stations which, evidently because of local influences of one kind or another, show extreme values of the potential gradient at times differing an hour or more from the average times, and there are some land stations which exhibit double maxima and minima in the diurnal variation of the potential gradient. It is generally found at these latter stations that one of the maxima and one of the minima values occur near the average times of extremes of the potential gradient in undisturbed regions. Suffice it to say that all available data at hand at present show that if the hourly values of the atmospheric potential gradient be plotted according to universal time, there will be found a general agreement in phase among the curves for stations in very remote regions, such as is not exhibited if the hourly values be plotted according to local time.

As regards a possible relationship between solar activity and the atmospheric potential gradient, I beg leave to refer the interested reader to my previous articles in NATURE and in the issues of *Terrestrial Magnetism and Atmospheric Electricity*, for March and December 1924, and March 1925. In the last-cited article, p. 17, will be found an extract from the Potsdam observations, published in 1924, showing that Dr. Kähler agreed with me that the Potsdam series, owing to the severe climatic conditions to which that station is subject, is not well suited for investigations as to a possible effect of sunspottedness on the atmospheric potential gradient. But even if the Potsdam series is included in the combined available data at Eskdalemuir (Scotland), Kew (England), and Ebro (Spain), for the complete solar cycle 1913-1922, a positive or direct correlation between atmospheric potential gradient and sunspottedness is found, which amounts to $0{\cdot}54 \pm 0{\cdot}15$, if no account of drift (my *t*-term) arising from one cause or another is taken into account, and to $0{\cdot}78 \pm 0{\cdot}08$, if corrections be made for drift as was done in the volume reviewed by Dr. Chree.

I intend publishing elsewhere some later evidence bearing on this important matter.

It will probably be necessary to await the completion of another cycle and the accumulation of data at widely distributed stations, not subject to local disturbing influence, before all the questions arising as to the precise nature of any solar activity influence on atmospheric electricity may be definitely settled. However, renewed interest has been aroused in the problem, and it is also gratifying in this connexion that, beginning in 1928, the observational work in atmospheric electricity aboard the *Carnegie* will be resumed.

LOUIS A. BAUER.

Department of Terrestrial Magnetism,
Carnegie Institution of Washington,
Washington, D.C., Jan. 31.

If I drew an erroneous inference as to the *Carnegie* reduction factors I regret the fact; but if so, it seems a case not of the reviewer's inadvertence but of the inexactitude of the language quoted in the review. Consultation of pp. 207-209 still leaves uncertainty as to what really happened. On p. 209 it is stated, as Dr. Bauer remarks, that the final mean results were based on "all reduction-factor observations . . . during the years 1915 to 1921," but we should infer from p. 207 that after an observation on April 1915—the original deductions from which we learn from p. 209 were from 24 to 35 per cent. in error—no further observations were taken until the commencement of Cruise VI. (1919 presumably). The other observations chronicled occurred in 1921. I referred to the point in connexion with the question whether the neglect of Potsdam results, which did not support a sunspot influence, was justified on account of an alleged uncertainty in the reduction factor, an uncertainty which seemed to me unlikely to be greater than that affecting the *Carnegie* factors. The rejection of Potsdam data is, however, now advocated on the ground of "the severe climatic conditions to which that station is subject." To this we can only say, what of Eskdalemuir?

How best to deal with the non-cyclic element is, as Dr. Bauer says, a disputed question, but the fact remains that an undesirably large uncertainty owing to unascertainable n.c. changes enters into those observations taken on the *Carnegie* which seemed specially intended for the elucidation of the diurnal variation. At its recent meeting in Zürich the Magnetic Commission of the International Meteorological Committee passed a resolution recommending that, whether n.c. corrections are applied or not, the n.c. change corresponding to any diurnal inequality should be shown explicitly. The news that further observations by the *Carnegie* are contemplated in 1928 is welcome, and it is to be hoped that n.c. uncertainties will be avoided so far as possible.

There is no inherent improbability in a sunspot influence on atmospheric electricity, but there has not been that general agreement between different stations and epochs experienced in the case of terrestrial magnetism, and a reserve of judgment can do us no harm. I think it is also the wise course at present to keep an open mind as to whether the diurnal variation of the potential gradient at sea and in polar regions follows universal time. But as regards ordinary land stations, we can scarcely admit the existence of a prepotent term involving universal time, unless we are prepared to scrap many results accepted at present. At most land stations the diurnal variations near midsummer and midwinter differ considerably in type; at Eskdalemuir and Pavlovsk, where the principal minimum in summer occurs near local noon, the difference is profound.

C. Chree.

Behind the Divining Rod.

I have read, not without surprise, the review in Nature of Feb. 26 under this heading.

I scarcely think it can be truly said that "the use of the divining rod has been looked at askance by men of science." Distinguished geologists have not averted their eyes, and have not neglected to subject its powers, or rather the power of the diviner, to experimental tests, but always with an unfavourable result.

Water is in many places sufficiently widely distributed to afford a fair chance to any one who says "put a hole down here and you will find it," and sometimes there are surface indications which will guide a good observer who may have no knowledge of geology. Occasionally the dowser makes an unexpected hit, but remarkable coincidences are not unknown in other walks of life.

The question has been investigated by the officers of the United States Geological Survey, who found that the successes of the dowser were less numerous than the laws of chance would have led us to expect. Perhaps geologists are to blame for not making the facts more generally known, but their time is usually so fully occupied in serious research that they have none to spare for the exposure of what they have come to regard as a popular delusion. Nor should I be writing now were it not for the serious mischief which is likely to result and has, indeed, already resulted from a recrudescence of this belief in the occult. Too many cases have come under my own observation of misspent labour and money due to misplaced confidence in the powers of the diviner.

The success of dowsers who have acquired reputation are recorded, but of their failures we hear nothing, yet they are often the more remarkable. Employers, who sometimes can ill afford it, suffer in pocket and do not complain; they are unwilling even to give the name of the dowser who has "let them in." I should not myself have any knowledge of these failures were it not that our Geological Department, especially my friend and assistant Mr. C. J. Bayzand, takes a lively interest in water supply and the application of our knowledge of the structure of the country to the finding of water. We are thus brought into contact with dowsers.

Perhaps I may be allowed to give one example of failure of several from out my own experience. One of my friends, having built a house in the country, had to be provided with water, and a dowser was called in to exercise his art. Acting on his advice the well was sunk in the Kimmeridge clay and, as might have been expected, after reaching a depth of nearly fifty feet it gave no sign of water. I was then asked how much deeper it would be necessary to go, and was able to give a definite answer. The distance was close on 68 feet; but I was also able to add that plenty of good water could be got from the Lower Greensand at several places within twenty yards of the ill-chosen spot and at a few feet from the surface. Here the chances were ten to one in favour of the dowser, and his rod gave him the wrong one.

Again, much is heard of the rare cases where a dowser has made a hit after the professional geologist has failed, but instances to the contrary pass without comment. Yet they are not infrequent. Here is a very recent one.

In a district where water could be found at any spot within a mile's distance from a certain village a dowser chose his site for a well; the well was sunk to a depth of 38 feet, but no water was found. The dowser said it was no use to go any deeper, and frankly admitted that he had failed. A geologist was consulted; his advice was to sink a little deeper, and he predicted that water would be found well within an additional 12 feet. The well was deepened and plenty of water was struck at 42 feet. If the dowser could find water at the surface, why not when he was within a few feet of it?

W. J. Sollas.

University College, Oxford,
Feb. 27.

I have every sympathy with Prof. Sollas and with all geologists whose scientific studies have been impudently challenged by ignorant charlatans. But I have met one honest and modest dowser who never exercised his powers for payment and had no theory as to the nature of the faculty which he believed he possessed. From the cases described by

Sir William Barrett, it appears that there are other dowsers who are honest, and it really seems to me that the cause of the dowser's sensations which may lead to the discovery of water is as worthy of study as, say, the polarisation of light that may be used for the microscopic determination of minerals. The investigation may, I think, be better undertaken in either case by specialists who are not concerned with the applications. If there is anything in water-divining, I am sure that it is not occult in the sense of "involving the supernatural, mystical, magical," and if it be occult in the sense of being "beyond the range of ordinary knowledge" (both definitions are given in the Concise Oxford Dictionary) I only urge that efforts should be made to extend that range as it has been extended in recent years to clear up other obscure phenomena. HUGH ROBERT MILL.

The Pressure of Gaseous Mixtures.

A CURIOUS and somewhat unexpected property of the pressure of a gaseous mixture has come to my notice from an examination of some recent experimental work. Holborn and Otto (*Zeit. f. Phys.* 23, 77, 1924; and 33, 1, 1925) have determined the isotherms of a mixture of helium and neon, and of helium and neon alone, and have shown that the isotherms can in each case be represented with great accuracy by a formula of the type

$$pv = A + Bp,$$

when A and B are given suitable values. Since B is small (of the order 10^{-3}), this equation can also be

$$pv/A = 1 + B/v,$$

where v in each case is the ratio of the volume to the volume under standard conditions, and is therefore inversely proportional to the molecular concentration. It follows that B is a measure of the deviation from the perfect gas law. The curious fact emerges that for the same temperature the value of B for a binary mixture may be greater than that of either of the constituent gases. In other words, the pressure of a gaseous mixture may be greater than that of either of its constituents, even when the molecular concentration and temperature are in all cases the same.

I hear, too, from Prof. Masson that Dr. Gibby and he have also discovered the same phenomenon independently in some experiments with mixtures of hydrogen and helium. They are at present extending their work in order to examine this question more closely.

The explanation is to be sought in terms of intermolecular forces. Cohesive forces between molecules tend to lower the pressure, while repulsive forces tend to increase it, and the relation of the one effect to the other depends on the temperature. A mathematical investigation for the particular case when both fields can be represented by inverse power laws (*Proc. Roy. Soc.*, A, 112, 214; 1926) shows that at low temperatures the cohesive forces outbalance the repulsive and the deviation from the perfect gas law (B) is negative. With increasing temperature the effect of the repulsive fields becomes increasingly important until ultimately B becomes positive. Finally, a temperature is reached for which this positive deviation is a maximum, and then the correction falls asymptotically to zero.

This maximum property of the deviation, indicated by theory, is borne out by experiment (Holborn and Otto, *Zeit. f. Phys.*, 23, 86; 1924). The temperature at which the deviation is a maximum is − 140° C. in the case of helium, 150° C. in the case of hydrogen, 260° C. in the case of neon, etc.

In this maximum property lies the explanation of the increased pressure of the gaseous mixture. The temperature of maximum deviation of a mixture lies between those of its two constituents, and near this temperature the deviation of the mixture from the perfect gas law is greater than that of either of its constituents. For a certain range of temperature the pressure of a gaseous mixture may therefore be greater than that of the same concentration of either gas alone.

Furthermore, theory provides an expression for the relative proportions of the gases of a mixture for which the pressure is a maximum at a given temperature. The already-mentioned work of Dr. Gibby and Prof. Masson will, it is hoped, prove to have provided experimental evidence to test this result.

J. E. LENNARD-JONES.

Physics Dept., The University, Bristol.

Members and Correspondants of the Académie des Sciences, Paris.

IN an obituary notice of the late Sir George Greenhill, published in NATURE of Feb. 26, it is stated that he was "a corresponding member of the Paris Academy of Sciences." Sir George was *not* a corresponding *member* of the Academy of Sciences. He was a 'Correspondant' of that Academy 'pour la section de mécanique,' elected in 1921. Similarly, it is stated in the same issue in the obituary notice of the American palæontologist Walcott, that that distinguished American was "a corresponding member" of the Academy of Sciences of Paris. He was not, but was elected by that Académie as 'Correspondant' in the section of mineralogy in 1918. In 1919 he vacated that place on being elected one of the twelve 'membres associés étrangers' of the Academy.

The fact is that the title 'corresponding member' is not employed by the Académie des Sciences—nor by the other Académies which are united as the 'Institut de France.' The individuals constituting one of these Academies are in the first place "Messieurs les Académiciens, membres titulaires de l'Académie." In the Académie des Sciences there are 68 of these 'titular' members, to whom have been added by successive decrees of the State government—10 membres libres, 6 membres non-résidants, 6 membres de la division des applications de la science à l'industrie; and 12 membres associés étrangers. These 102 'membres' of the Academy are classed officially as 'Messieurs les Académiciens,' 'membres de l'Institut.'

Each Academy, excepting the Académie Française, has in addition been empowered to elect *not* 'corresponding members' but *Correspondants*. The Académie des Sciences has 116 'correspondants,' approximately ten to each of the sections into which the Academy is divided. They are *not* 'Académiciens' nor 'Membres de l'Institut.'

There is no restriction as to the nationality nor as to the residence of persons eligible by the Académie des Sciences as "Correspondants." They may be French nationals or foreigners.

The 'membres associés étrangers'—of which there are twelve in the Académie des Sciences—are the nearest equivalent to the 'corresponding members,' the 'foreign members,' and 'foreign correspondants' of some other academies and societies.

Very full information as to the Institut de France and the members and correspondants of its five Académies is to be found in the "Annuaires" published yearly by the Institut and by each Academy. An English account of the history and present organisation of these great bodies would be welcome at this moment, as it would tend to prevent mistakes and confusion in regard to the significance of the titles conferred by them. It is, indeed, most desirable that such an account should be published. Three or four pages of Nature would suffice for a brief and accurate statement. L.

London, Mar. 5.

Solar Radiation and Diathermancy.

The accompanying record (Fig. 1) of the temperatures attained by six thermocouples embedded in a nine-inch brick wall may be of interest. The thermocouples, protected by a thin layer of Chatterton's compound, were embedded at 1/32, 1/16, 1/8, 1/4, 1/2, and 1/1 of the thickness of the wall, which faces west by south.

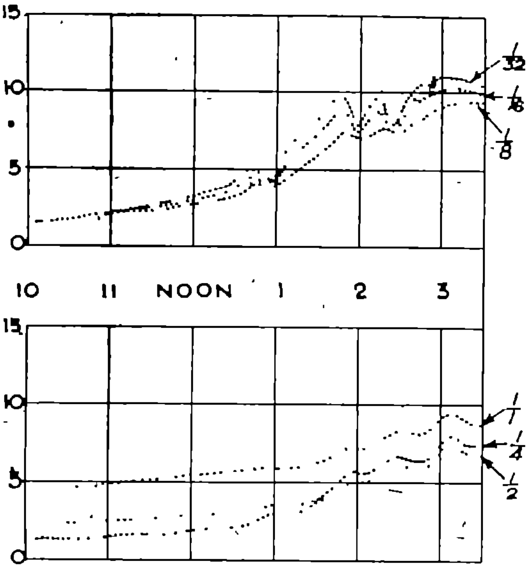

Fig. 1.

A considerable time is required for the transmission of (a wave of) heat by conduction through nine inches of brick, and the rapid response shown in the lower half of the record indicates that an appreciable amount of solar energy is transmitted as radiation.

The troughs at 2 p.m. and 2.25 p.m. in the upper half of the record correspond to the shadows cast by the sides of a wooden ladder. A. F. Dufton.

Building Research Station,
Garston, Herts., Feb. 23.

Sand-flies and Chinese Kala-azar.

Up to the present there have been no records of any infection being produced from Phlebotomus fed on cases of kala-azar, therefore the results of the following experiment may be of interest, since they show that the flagellates which develop in the midgut of sand-flies are capable of producing the infection when they enter a susceptible host. The details of the experiment are as follows:

On Aug. 29, 1926, a female hamster (*Cricetulus griseus*) was inoculated intraperitoneally with a saline suspension of the midgut contents of five infected *Phlebotomus sergenti* var. (exp. S. 75) that had been fed three days previously on a hamster infected with the parasite of Chinese kala-azar. The sand-flies had been kept at a temperature of 30° C., and of those dissected after a three-day interval, six out of eight contained flagellates in the midgut. On Jan. 26, 1927, after an incubation of approximately five months, this hamster died. On examination the spleen was found to be moderately enlarged, and films made from the spleen, liver, and bone marrow, all contained enormous numbers of parasites.

This experiment shows that *Phlebotomus sergenti* var. is capable of harbouring the parasite of kala-azar in a virulent form, and that the parasite is in an infective stage in the midgut three days after being ingested by the insect. The experiment supports the hypothesis that sand-flies are responsible for the transmission of the parasite of this disease.

Edward Hindle.
W. S. Patton.

Kala-azar Commission of the Royal Society,
Tsinan, North China,
Jan. 28.

Amphipneustes.

The Research item headed "Antarctic Echinoidea" (Nature, Feb. 19, p. 294) says: "Antipneustes is a name that replaces Amphipneustes Koehler 1901 to avoid confusion with the unknown Amphipneustea Wiegmann." Since the name Amphipneustea was as unknown to me as to the writer of that note, I have taken some trouble, with the help of Mr. C. D. Sherborn, to get to the bottom of the puzzle. First of all, it appears that the name Antipneustes was proposed, at Prof. Koehler's request, on p. 427 of Lambert and Thiéry, "Essai de nomenclature raisonnée des Échinides," published in 1924, but only just obtained for the Natural History Museum. The supposedly conflicting name Amphipneustea is, on p. 428 of that work, credited to Wiegmann, 1837, without further reference. The "Nomenclator" of Agassiz helps one to track this down to A. F. A. Wiegmann and Ruthe, 1832, "Handbuch der Zoologie," p. 527. The name, however, is applied to a family of Pulmonate Mollusca, and therefore could not conflict with Amphipneustes Koehler, even if the spelling were the same. It may be mentioned that, in 1820, B. Merrem, "Tent. Syst. Amph.," gave the name Amphipneusta to a family of Reptilia.

The upshot of this is that Amphipneustes Koehler 1901 stands, and that Antipneustes is an unwanted synonym; and the moral is: "Verify your references!" F. A. Bather.

Carbon Monoxide Poisoning in the Absence of Hæmoglobin.

May I remind Mr. Haldane (Nature, Mar. 5, p. 352) that it was shown by Faraday, in 1834, that the interaction of hydrogen and oxygen, at a clean, cold platinum surface is prevented by the addition of carbonic oxide. Of course, we never discuss these fundamental things in text-books. Still, his observations are an interesting and useful addition to those of Warburg. I have considered the nature of the influence in my article on catalysis (Nature, Aug. 22, 1925), published in the last Solvay Report. The effect of carbonic oxide upon animals would seem to be that of displacing oxygen from hæmoglobin. I am not aware of any proof that it inhibits oxidation, except by reducing the supply of oxygen. What is surprising is, that carbonic oxide is not generally a more active substance: unfortunately for it, fortunately for us, perhaps (though maybe the reverse holds good), its heat of oxidation is slightly lower than that of hydrogen—hence these tears.

Henry E. Armstrong.

Some Systematic Features in the Distribution of Stars.

By FREDERICK H. SEARES, Mount Wilson Observatory, Pasadena, California.

THE mean distribution of the stars with respect to magnitude and galactic latitude derived by Prof. van Rhijn, Miss Joyner, Miss Richmond and myself,[1] is expressed through values of $\log N_m$ (N_m = number of stars per sq. deg. brighter than m) which for the same latitude, north and south, are the same in all galactic longitudes. The supposition that densities having this characteristic may represent the observed features of stellar distribution assumes the sun to be at the centre of a stellar system having rotational symmetry. Although sufficiently exact for many purposes, this assumption is only a first approximation to the state of affairs in the heavens.

To obtain a further approximation, we may examine the deviations from the mean distribution observed in many parts of the sky. A discussion of the available data by Miss Joyner and myself reveals a conspicuous periodic irregularity extending into high latitudes, which, next to the galactic concentration, is perhaps the most striking feature of the distribution of stars over the sky.

With some additions which need not be detailed here, we have used the same observational material as for the derivation of the mean distribution, namely, the Mount Wilson Catalogue of Selected Areas, the Harvard-Groningen Durchmusterung, and counts from zones of the Astrographic Catalogue published by Turner. The data from the last two sources were reduced to the international photographic scale with the aid of the Mount Wilson Catalogue and the mean distribution table.

Values of the deviation Δ have, in general, been calculated for 10° intervals in longitude and latitude, from 70° N. to 70° S., for each of the limiting magnitudes 9, 11, 13·5, 16, and 18. An important exception occurs only in the case of declinations south of −15°, where, for the faint stars, we have only the data from the Harvard-Gronigen Durchmusterung, with a limiting magnitude of 16·86. Since the systematic change in Δ with magnitude is slow, we have assumed that the deviations found from this catalogue might be taken as representative of those for the limits $m = 16$ and 18 and used with data for these limits from other parts of the sky.

The values of Δ for the same limiting magnitude and the same latitude show in all cases a variation with longitude which can be represented by a simple cosine term. Other irregularities are of course present, notably those corresponding to the obscuration in Taurus and Ophiuchus and to the abrupt changes in density in and near the Milky Way; but underneath all these the large-scale, periodic fluctuation is easily discerned. In spite of some progression, the longitudes of maximum deviation are much the same for all magnitudes and in all latitudes. Further, the amplitude of the variation decreases with increasing distance from the Milky Way; and, finally, the constant term in Δ is always small, which shows that the asymmetry between northern and southern galactic hemispheres is slight.

In a general way these are the characteristics to be expected from an eccentrically located sun, only slightly removed from the galactic plane. Certain systematic differences in the deviations for the two hemispheres suggest, however, the probability of an error in the adopted position of the galactic pole, which is that of Gould. The mean distribution table, although based on data referred to a possibly erroneous pole, is little affected by such an error. The combination of observed densities from all longitudes made in forming this table eliminates the first-order terms in the error; but when observed densities are compared individually with the mean distribution, the error appears in the deviation Δ.

We were thus led to the equation of condition

$$\Delta = s + G + F\cos(\lambda - L) \mp k\cos(\lambda - L_0),$$

in which the upper sign refers to northern latitudes, the lower to southern, s provides for a possible systematic correction to the mean distribution table; k depends on p, the polar distance of the true galactic pole, in longitude L_0, relative to the adopted pole.

The use of this equation only removes the restriction that the sun should be centrally located among the stars, the original assumption of rotational symmetry being tacitly retained. Starting from this modified assumption, we interpret L as the longitude of the centre of the stellar system, and F and G as functions of the latitude, the space-density, and the rectangular co-ordinates of the centre of the system relative to the sun. Although sufficient for present requirements, the equation is correct only to quantities of the first order in p and ρ/R, where ρ is the distance of the sun from the centre and R the radius of the system.

Values of the parameters were calculated for each pair of latitudes, north and south, at 0°, 5°, 10°, 20°, 30° . . . 70°, and where possible, combined into means which are collected in the accompanying table. Only s, which is of no interest here, has been omitted. For L, L_0, and p, the average deviations for results from a single pair of latitudes are 7°·0, 10°·4, and 1°·5, respectively. The internal agreement therefore indicates uncertainties in the tabulated means of the order of 2° to 4° for L and L_0, and of something less than 1° for p; but

m	L.	L_0	p.	$2F$.	$2G$.
9·0	267°	275°	8°·1	0·380	−0·127
11·0	270	296	6·8	0·434	−0·101
13·5	275	319	8·0	0·429	−0·095
16·0	310	357	4·1	0·690	−0·012
18·0	319	350	2·7	0·668	+0·002

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[1] Cf NATURE, 115, 948, 1925; *Mt. Wilson Contributions*, No. 301; *Astrophysical Journal*, 62, 320, 1925.

residual systematic errors in the data increase these limits considerably; the actual errors in the means are probably of the order of the average deviations quoted.

The significant result is that zones in all latitudes up to 70° show the periodic irregularity of distribution corresponding to the foregoing formula, and give accordant values for the longitude of the centre of the system and the position of the galactic pole. Further, the errors of the respective means are such as to leave the obvious dependence of these quantities upon limiting magnitude open to no serious doubt.

The quantities F and G, as already noted, are functions of the latitude, the space-density, and the distance of the sun from the centre of the system. We should like to utilise their values from all latitudes in a determination of the position of the sun. Substitution of the correct function for space-density and allowance for latitude should reduce all the values of F and G for a given magnitude to constants, from which the co-ordinates of the centre could then be determined. Uncertain knowledge of the density function, together with the inherent complexity of the problem, blocks this direct method of procedure. The use of the simple but incorrect assumption of constant space-density leads to manageable formulæ, but leaves an uncompensated variation in F, and hence yields no very useful result. It does, however, prove again a well-known fact, for the residual variation in F contradicts the assumption of constant density and shows that the stars thin out with increasing distance.

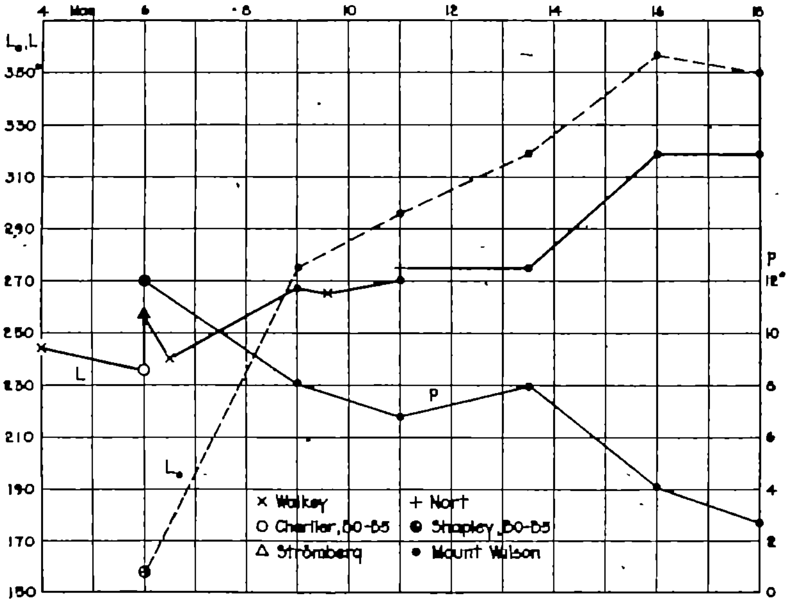

FIG. 1.

Because of the difficulty of utilising all the data, values of F are given only for the galactic region, means for 0° and 5° being tabulated in order to reduce the influence of accidental error. Actually, the double value is given, since that quantity is the logarithm of the ratio of the number of stars in longitude L to the number in longitude $180° + L$. This ratio also depends on the limiting magnitude, increasing from about 2·5 for $m = 9$ to approximately 5 for $m = 18$. An average of 4, combined with the density law of Kapteyn and van Rhijn (which requires revision, and, moreover, is not strictly applicable), leads to a value of 1200 parsecs for the distance of the sun from the centre of the stellar system. This estimate neglects certain obvious refinements, but nevertheless must be of the right order of magnitude. It is so much smaller than Shapley's value of 25,000 parsecs for the distance from the centre of the system of globular clusters, that we may say at once that this system cannot be concentric with the general system of stars now within reach of our telescopes. It is well to remember, however, that the centres of both systems—of clusters and of stars—have practically the same longitude.

The values of G change so little that it seems permissible to tabulate means for all latitudes as an indication of the small displacement of the sun from the galactic plane. A value of $2G$ equal to 0·10 for all limiting magnitudes would correspond to a distance of some 30 parsecs. Actually, however, the asymmetry is appreciable only for stars brighter than the fourteenth magnitude, which show an excess of about 25 per cent. in the southern latitudes. For the lower limiting magnitudes the difference between the two hemispheres is vanishingly small, and we may regard the sun as situated almost exactly in the corresponding galactic plane.

On the whole, we conclude that the systems of stars defined by successive limiting magnitudes differ appreciably in both centring and orientation. In this connexion results by other observers may be recalled. Walkey, Charlier, and Nort found the following longitudes of maximum density:

Limiting *m*.	*L*.
4·0	244°
6·5	240
9·6	265
6±	236 (B0-B5 stars only)
11	275

From dynamical considerations of the characteristics of preferential motion ($m < 6\pm$), Strömberg inferred that the centre of the system might be found in longitude 257°, while Shapley, from a study of globular clusters, adopted 326°. Further, Shapley has shown that the B0-B5 stars brighter than 5·5 lie close to a plane fixed by the pole having the co-ordinates $L_0 = 160°$, $p = 12°$; while the nearer diffuse nebulæ, according to Hubble, define a ‘secondary galaxy’ for which $L_0 = 160°$, $p = 20°$. Other data and certain relevant comments might be added, but for the present account those quoted are sufficient.

The accompanying diagram (Fig. 1) shows the relation of all the results. Those just quoted both confirm and extend the conclusion derived from faint stars. In the systems defined by successive limits of brightness we find a continuous progression in the longitude of the centre and in the position of the galactic pole. The sequence seems to terminate with the galactic clouds; its upper end is the isolated group of helium stars known as the local cluster.

That the B0-B5 stars brighter than 5·5 constitute a local cluster seems clear. Most of these stars are within 500 parsecs and lie close to a plane inclined 12° to the plane of the Milky Way. The fainter B's (7·26-8·25), on the other hand, are more distant, and, as shown by Shapley and Miss Cannon, associated with the fundamental plane of the larger system. Direct evidence also connects some of the A stars with the local cluster. The present data, however, indicate that very faint stars, among them all spectral types, are included in its composition, or at least exhibit some of its characteristics. It is also evident that if the cluster is a separate dynamical unit, it must be much larger than hitherto supposed. Stars of the tenth to the fifteenth magnitude are certainly involved, because those brighter than the tenth magnitude are not numerous enough to influence appreciably the systems the limiting magnitudes of which are 12 or fainter. But these faint stars, which clearly show the progressive change in L, L_0, and p, extend to distances well beyond the most generously placed boundaries of the local system of B stars. It is perhaps questionable if the local cluster in this larger sense can be regarded as a separate unit; the progressive change in the characteristics of stellar distribution is possibly analogous to that shown by Strömberg to be a striking feature of stellar motions.

Fundamental Problems relating to River Pollution.

By H. W. Harvey.

The need for scientific research to provide a basis upon which to deal economically with the pollution of the rivers of Great Britain has been widely recognised during the last few years, and the Government is now prepared to provide adequate financial assistance for this purpose. It is of interest at the present moment to review the lines along which further research of a general character appears at first sight likely to prove most fruitful.

The types of pollution to which rivers and streams in England and Scotland are subject fall into two broad groups. In the first group fall *inorganic* compounds in the effluents from industrial undertakings, having a specific poisonous effect upon aquatic organisms. It may be taken that the chemist and engineer will find effective treatments for almost every such effluent, but their application will depend upon their cost; frequently the limited ground area available makes the simplest type of treatment, involving settling pits or the like, impracticable; frequently a partial treatment only is practicable, or necessary. In the latter case it is essential to know at what dilution the particular toxic substance will have a negligible effect upon various kinds of life natural to the river, for if the ordinary vegetable life in particular is seriously interfered with, slow-running water may be depleted of dissolved oxygen and the natural processes of self-purification cease.

An inquiry into the normal seasonal changes in the aquatic life of an unpolluted stream is already in progress, with the final object of finding the effect of various types of pollution upon them, and of rendering it possible to gauge the extent to which any particular stream is harmfully polluted. It is recognised that considerable quantities of some solutes and matter in suspension may be run into a river without causing any material harm, and a mere change in the nature of the fauna does not provide sufficient ground for recommending the possibly costly treatment of effluents, provided that the capacity of the water to purify itself is not interfered with. This involves a biological research of some magnitude, and certainly of a fundamental nature.

Into the second group fall a wide and varied class of *organic* waste products. If these are turned into a river in suspension they settle upon and stifle the plant life, forming a substratum for fungus growth over the stones, or give rise to putrefaction, which may also happen if organic matter is added in solution. It is the event of putrefaction which opens up problems of the greater interest and the greater complication. As cases in point, the water in which beet is scrubbed at sugar factories, the water in which beans are boiled in American canning factories, and wash water from milk factories containing whey and a little milk, if run direct into a river in any quantity, rapidly deplete its waters of dissolved oxygen and kill off the animal and plant life in the stream, the latter being replaced by a fungus growth attached to the bottom. This is not the case with all organic matter, for I have met with cases where the effluent from treated sewage or even untreated sewage in small quantities appears, if anything, to improve the fishing in swift-running streams.

The question of why quite a limited amount of some organic substances should render a river foul and completely change the animal and vegetable community in it will repay most careful investigation. One general explanation is that putrefaction in the water, by using up the dissolved oxygen, renders it insufficiently aerated. In extreme cases the oxygen content of polluted rivers may fall to zero, as found in the esturine water at Newcastle during periods when little fresh water is coming down the Tyne [1]; in other cases the absorption is not at all complete, yet the biological condition of the river is completely changed for some distance and fish die in the water, although cases have been quoted in which freshwater fish do not suffer from lack of oxygen when the water contains so little as 0·4 c.c. to 1·7 c.c. per litre, less than one-third of the amount necessary for saturation.

Other observers lay stress upon the effect of hydrogen ion concentration: it takes much putrefaction to reduce the pH of a natural water to less than 6, and some freshwater fish have been found flourishing in water of pH 4·4—probably an extreme case. Although changes between pH 6 and pH 8 do undoubtedly affect the nature of the fauna and perhaps of the flora, it seems unlikely that a river would be harmfully affected until the hydrogen ion concentration had risen to around pH 5·5. Wundsch[2] suggests an even lower limit.

The increase in partial pressure of carbon dioxide coincident with putrefaction may have a specific physiological effect additive to that due to a materially increased hydrogen ion concentration. Experiments by Wells[3] in America suggests that this is the case when in conjunction with a low concentration of dissolved oxygen, but these experiments are inconclusive since no account is taken of the hydrogen ion concentration. The influence, if any, of this factor in the deeper water of polluted streams is really unknown.

It appeared self-evident some two years ago, when examining rivers for harmful pollution by organic matter, that lack of oxygen alone, although an excellent indication, was not the only factor giving rise to an abrupt change in stream life, but that this was brought about through the interplay of several factors. Dr. Pruthi[4] very kindly undertook last year to investigate the possible physiological effect of the products of putrefaction upon fish. His painstaking investigation, although admittedly of a preliminary nature, shows that these products play a rôle in limiting fish life in waters where certain kinds of organic putrefaction take place, if not generally. In a 1 in 2000 solution of casein, peptone, or albumen which had undergone putrefaction, small fish quickly died, even after the solution had been thoroughly aerated and its hydrogen ion concentration had been reduced to a normal value for natural water. This is a definite evidence of the production of toxic compounds during the process of putrefaction of these proteins.

The toxic compounds were, in part at least, volatile, for the distillate was observed to be highly poisonous to the test fish. An observation suggested that such compounds are readily oxidised, for heating a putrefied casein solution to 70° for twelve hours rendered it innocuous, whereas before heating it killed test fish in one hour. These experiments bring out the significance possessed by the toxic compounds which appear as by-products of protein putrefaction, a factor hitherto almost ignored. It will be a fruitful problem to investigate the nature and production of these compounds from various organic substances likely to be thrown into rivers, their effect upon the fauna generally, and the possibility of accelerating their oxidation.

Until knowledge has been obtained of how each factor affects not only fish but also other forms of aquatic life, particularly diatoms, attempts to deal with effluents containing dissolved organic matter must remain empirical. As soon as a sound basis of theoretical knowledge is available, the risk of expensive installations proving unsatisfactory will be greatly minimised, and firm ground will be provided for efficient legislation causing the least possible expense to the various interests involved.

In attacking problems of this nature, provided the investigations proceed without undue haste and there is some freedom allowed to follow up cognate issues which present themselves during the course of every research, it is impossible to foresee where new knowledge may in time lead. We cast away many tons of combined nitrogen and phosphorus and of fats into our rivers every year. Our inland waters are capable of yielding many more tons of edible fish annually, and it is very possible that this will become an economic possibility in the not far-distant future.

BIBLIOGRAPHY.

1. GILL, R. "Report of Dove Marine Laboratory for 1926," pp 26-32.
2. WUNDSCH, H. *Handbuch der Binnenfischerei Mitteleuropas*, 6, 189-221; 1926.
3. WELLS, M. M. *Biol Bull.* 25, 337-347; 1913
4. PRUTHI, H. S. *Journal of the Marine Biological Association*, 14, 729-739, 1927.

Comets and the Law of Gravitation.

By Dr. A. C. D. CROMMELIN.

One of the most interesting results of the discovery of the law of universal gravitation was the light that it threw on the nature of cometary movements, which had previously baffled astronomers. In classical times comets seem to have been generally recognised as heavenly bodies: this is illustrated by the remarkable prediction of Seneca: "Some day there will arise a man who will demonstrate in what regions of the heavens the Comets take their way; why they journey so far from the other planets; what their size, their nature." This prediction received a striking fulfilment some 1600 years later, when Newton's brilliant discovery of the law of gravitation, which permits motion in any of the conic sections about a centre of attraction, made it at last possible to determine the orbits of comets.

After the time of Seneca, science in Europe underwent a remarkable retrogradation as regards the nature of comets. They came to be regarded as mere atmospheric exhalations, a supposition that their great size and rapid motion rendered plausible, but capable of easy refutation from the fact that they rise and set like the stars. The erroneous conception had two unfortunate effects: first, it led to comets being regarded as the bearers of plague, famine, and war; secondly, it caused very little attention to be paid to their positions among the stars, so that in several cases this is far more precisely stated in Chinese and Japanese records than in European.

Tycho Brahe made it clear, by the absence of appreciable parallax, that comets were at least several times more remote than the moon, and so restored them to the status of heavenly bodies. When Kepler, from a study of Tycho's observations, demonstrated the elliptical character of the planetary orbits, the idea occurred independently to Hevelius, Borelli, Lower, and Dörfel that comets might also have elliptical paths of a much more elongated character than those of the planets, so that they remained invisible for the greater part of their period of revolution. These ideas remained merely conjectural until Newton had demonstrated that the law of universal gravitation, varying inversely as the square of the distance, gave a full explanation of the lunar and planetary movements, and indicated the possibility of motion in conic sections of any eccentricity.

Thus at last it became possible to calculate the orbits of comets. Many difficulties arose in the practical work, owing to the roughness of the observations and the small arc covered by them. It has needed long experience and the continued work of a long series of mathematicians to reduce the calculation to its simplest form. At first it offered great difficulties even to Newton. He was unfortunate in choosing as one of his examples the great comet of 1680–81, which had the very small perihelion distance 0·006. It will be remembered that the 'daylight' comet of January 1910, which also had a small perihelion distance, baffled the orbit computers in the early days of its apparition. So Newton is stated to have lost two months in 1685 in attempting to deduce the orbit of the 1680 comet, though he ultimately succeeded in obtaining a tolerable result, and in proving that the morning comet of November 1680 was the same body that was seen in the evening in the following January.

Newton has freely acknowledged in the "Principia" the great debt that he owed to Halley for carrying the cometary computations much further than he himself had the leisure or inclination to do. As is well known, Halley took up the application of the law of gravitation to comets with the greatest enthusiasm, and calculated the orbits of 24 of them from observations extending over two centuries, which he had collected with much diligence. He was rewarded for this great labour by the discovery of the periodic comet that bears his name, which he found to have appeared in 1456, 1531, 1607, 1682. He thus reduced these wandering bodies to recognised members of the solar system, his work being afterwards vindicated by the return of his comet in 1759, in almost exact accordance with his prediction. Thus it may be said that Newton's discovery, vastly useful as it was for the prediction of lunar and planetary motions, produced a still more revolutionary advance in the world of comets.

Dwelling-places, Portraits, and Medallic Illustrations of Newton.

THE particulars concerning the birth and upbringing of Newton, as well as his domiciliary situation and circumstances while at Cambridge, are so well known that they need no further narration. But his eventful and full life in London, in east and west, covering a period of thirty years, and when in the zenith of fame, may perhaps receive some attention. It suffices, as a preliminary, to recall that, in 1701, Newton resigned the Lucasian chair at Cambridge. He had earlier (1696) been appointed Warden of the Mint, and later (1699) Master.

DWELLING-PLACES.

Towards the close of 1697, Newton went into residence in Jermyn Street, where he stayed until 1710. From here he wrote to Flamsteed, under date 1698, whilst Bentley addressed a letter to him, so late as 1709, in this wise: "Sir Isaac Newton, at his house in Jermin Street, near St. James's Church, London." After a short stay in Chelsea, "near the College," Sir Isaac removed about the end of September 1710 to a large and commodious house in St. Martin's Street, Leicester Fields, occupying this as tenant during the rest of his life. Actually, however, he ceased to live in it from 1725, for, owing to indifferent health, he had gone into quarters at Kensington, dying there in 1727. It was in that year that his name was erased from the books of his former parish. The identification of the house in Kensington where Newton lived was established and recorded in 1852 by Mr. Joseph Jopling, an architect, who thereupon received the thanks of the president and council of the Royal Society. It was probably in early days within sight of Kensington Palace.

Newton had procured (with the active assistance of Wren), in the very year of the acquisition of a new domicile for himself, a home for the Royal Society in Crane Court, Fleet Street. Possibly, in determining this abode, he was mindful of the claims imposed upon his time by the weekly meetings of the Society. He would not have far to go from Leicester Fields to Crane Court.

In St. Martin's Street Newton lived in excellent style, kept a carriage, and maintained an establishment of three male and three female servants. Ample hospitality was proffered without ostentation or vanity, his niece, the accomplished Catherine Barton, presiding at the philosopher's table. She married John Conduit in 1717, who, in later years, wrote "nobody ever lived with him but my wife, who was with him near twenty years." Eminent foreigners visiting London were always sure of a warm welcome. Newton built a small observatory on the roof of his house. At the moment of writing, the foundations of a spacious new building are in progress on the site of the derelict residence of Newton. It may be hoped that a suitable commemorative tablet (more appropriate at least than that in Jermyn Street) will be affixed in due time.

Several engravings of the St. Martin's Street house are extant. There is one in the *European Magazine* for 1811. In Smith's "Historical and Literary Curiosities" is an engraving (published 1836) showing the interior of the observatory; and another of the house itself (published 1837). Long after Newton's death, a story got into circulation that the house was at one time taken by a foreigner, who built an observatory at the top, storing there some obsolete apparatus. He advertised the place as being on view in the state left by Newton, and many visitors were imposed upon. The circumstance is alluded to by J. T. Smith in "An Antiquarian Ramble in the Streets of London" (1846), and by the Rev. W. G. Humphry, sometime Vicar of St. Martin-in-the-Fields, in a pamphlet issued in 1857.

Portraits.

The lineaments of Newton have been conveyed to canvas, and thence to posterity, by many celebrated painters—notably by Kneller, Vanderbank, Thornhill, Charles Jervas, and Seeman. Many engravings from these personal studies have been produced by masters in their art; in addition, there are innumerable woodcuts. In the subjoined notice, while space permits only brief reference to selected examples of portraiture, some idea of the manner and time of presentment may, however, be gathered.

The earliest authenticated portrait of Newton is that by Sir Godfrey Kneller (deceased 1723) in the possession of the Earl and Countess of Portsmouth, at Hurstbourne Park. It represents him with long natural hair and shirt open at the neck. Painted in 1689, it shows Newton at the age of thirty-eight. A faithful engraving of this portrait was made by T. O. Barlow, R.A.

There is also a fine study of Newton by Kneller, painted in 1720, at Petworth House, Sussex, in the ownership of Lord Leconfield. The philosopher is represented nearly whole length, seated in an elbow chair, in wig, looking to right, the right arm resting on an abutment; in left hand, a glove. The picture was engraved in stipple by W. T. Fry for Edmund Lodge's "Portraits of Illustrious Persons" (folio 1831).

The three-quarter canvas by John Vanderbank in the National Portrait Gallery, St. Martin's Place, is of high interest. Newton, with flowing hair and white neckerchief, is represented seated in a high-backed chair, one arm resting. An open book on a table is before him, a leaf of which he holds. In the background is a globe. The legend appended describes him as "The Great Philosopher; Discoverer of the laws of gravitation, and of the nature of light and colour. Author of the *Principia*." The pose of the head, drawing of the hands, and fine colouring of the face, arrest attention. The whole composition is in harmonious balance. We know that Vanderbank's pencil received the stimulus of a long and faithful attachment to Newton.

At the Royal Society, holding place of honour in the meeting-room, over the president's chair, is John Vanderbank's impressive portrait of Sir Isaac, painted in 1726, when Newton was eighty-four years old. It is nearly whole-length, and the subject is seated in an armchair, in velvet gown, with long white neckerchief and white ruffles at the wrists. A mezzotint from the portrait was engraved by J. Faber, jun. The picture was presented to the Royal Society in 1841 by Mr. C. B. Vignoles, F.R.S.

Mention must not be omitted here of Vanderbank's portrait of Newton, painted in the year previous to the foregoing. The original is at Trinity College, Cambridge. An engraving from it forms the frontispiece to the "Principia," third ed., 1726.

The Royal Society possesses also a portrait by Charles Jervas, given in 1717 by Newton himself. No particulars of this gift, by letter, exist. Doubtless it hung in Crane Court. The painter was sometime a pupil of Kneller.

Martin Folkes, often Sir Isaac's deputy in the chair in his declining health, gave the Society a portrait which is signed by Vanderbank.

One of the most interesting Newtonian portraits is that by Enoch Seeman, painted for Thomas Hollis, F.R.S. It is recorded in Hollis's "Memoirs" (2 vols. 1780, privately printed, many plates) that on Oct. 29, 1761, he presented to Trinity College, Cambridge, an original portrait of Sir Isaac Newton "painted in the year 1726." Comment is made that "Mr. Hollis's expenses this year [1762] to artists in the painting and engraving way appear to have been very considerable, particularly to Signor Cipriani; and likewise to Mr. MacArdell for a mezzotint of Sir Isaac Newton from the portrait presented to Trinity College." This engraving, it should be said, was published in Vol. 2 of the "Memoirs," and bears a quotation from Voltaire. Its rarity has led to the acquisition of the "Memoirs" for the purpose of abstraction of the engraving. Instances are within the writer's knowledge. A copy of the "Memoirs" exists in the library of the Society of Antiquaries, but we look in vain for the mezzotint. On the other hand, a copy in the Royal Institution is perfect in all respects. James MacArdell was a brilliant craftsman who executed plates of many persons of distinction. He died in London in 1765.

In the drawing-room of the Master's Lodge, Trinity College, Cambridge, is a half-length portrait of Newton, in gown, executed in 1710 by that eminent artist James Thornhill (knighted 1720), who was court sergeant-painter in Newton's London days. It was bequeathed to the College by Dr. Richard Bentley. Writing to Newton in 1709, Bentley says: "I hope my picture at Thornhill's will have your last sitting before you leave the town." It was engraved as an oval by J. Simon.

The Countess of Portsmouth kindly supplies the information that at Hurstbourne Park, in addition to the Kneller of 1689, and one of 1702, as well as a head by Thornhill, the family possess a small sketch, believed to be by Kneller, a bust by

Roubiliac, and a death mask of Newton, the last named presented by Mr. Alfred Gilbert, R.A.

Medallic Illustrations.

Numerous medals and tokens were in circulation at home and abroad after Newton's death. Most of them bear the bust of Newton; on a reverse of one is a representation of Newton's monument in Westminster Abbey. A medal (it is rare), designed by James Roettier in 1739, shows the bust of Newton, and for reverse, science, personified as a female, with wings, is seated on a rock, holding a diagram of the solar system. The Royal Astronomical Society's gold medal bears Newton's head. This yearly gift replaces an earlier type by George Mills, awarded for the first time in 1822, but superseded in 1831. On the reverse was an inscription taken from verses by Halley prefixed to the first edition of the "Principia." The Royal Society's annual Royal Medal perpetuates Newton through a reproduction on the reverse of Roubiliac's statue in the ante-Chapel of Trinity College, Cambridge. McGill University, Montreal, awards a medal which carries a head of Newton. The list admits of extension.

T. E. James.

News and Views.

The Grantham commemoration of Newton on Mar. 18–20 was a brilliant success and reflected much credit on the Yorkshire Branch of the Mathematical Association and its able and active president, Prof. S. Brodetsky. It would be difficult to say which was the best-arranged part of the programme—the scientific meeting, the visit to the Manor House at Woolsthorpe, the dinner, or the service in Grantham Church. All went off without the smallest hitch. But there can be no doubt as to the most impressive part. The gathering in the magnificent church, crowded in every corner, the bright robes and the band of scholars, the hearty singing of the finest old psalms and hymns, the exquisite choice of passages for reading, above all, the superb sermon of the Bishop of Birmingham, made a profound impression. The end fitly crowned the work of commemoration, and those who came from a distance—some 150 of them—dispersed in the afternoon full of gratitude to Prof. Brodetsky, Mr. A. B. Oldfield, and other devoted members of the Mathematical Association, as well as to Mr. Christopher Turnor, Sir Charles Welby, the Mayor of Grantham, and others who generously provided hospitality for some of the visitors.

Celebrations are now of almost monthly occurrence, and some people may think there are too many of them. Happily in the case of the Newton commemoration there was no doubt from beginning to end, and the concurrence of the many sides of his marvellous character was well brought out. Even the weaker points of his humanity found their recording angels in the comparative privacy of the after-dinner speeches. His interest in the 'stinting' of the farmer on his Manor of Woolsthorpe and in the actual working of the estate, his action at the Mint which restored the guinea to its face-value, and his own operations in the share market, these were probably the sides of his work which were new to the largest number of the audience. To these should be added Dr. Barnes's discovery of the state of his theological beliefs and the probable reason why he abstained from taking orders. Altogether, the occasion was worthy of its subject, and stands out as a very moving and instructive commemoration. For the purposes of education such a function has a double aspect, and it is impossible to say which is more valuable. On one hand, it introduces a large public to the work of men whose thought in its entirety is inaccessible to most, but who have a human and a beneficent quality which all can appreciate. On the other hand, it turns the thoughts of men of science to the human and historical aspects of their subject. If we think of the great founders, we are bound to fit them into their place in the evolution of thought, to regard them, not only as real human beings like ourselves, but also as steps in the upward march of the human spirit.

Several telegrams and other messages were read at the scientific meeting and the dinner. Prof. Einstein sent a letter to Dr. Jeans, secretary of the Royal Society, but it was unfortunately not handed to Dr. Jeans in time to be read. We are glad, however, to be able to publish a translation of the letter. "More than any other people," wrote Prof. Einstein, "you Englishmen have carefully cultivated the bond of tradition and preserved the living and conscious continuity of successive generations. You have in this way endowed with vitality and reality the distinctive soul of your people and the soaring soul of humanity. You have now assembled in Grantham in order to stretch out a hand to transcendent genius across the chasm of time, and to breathe the air of the precincts where he conceived the fundamental notions of mechanics and of physical causality. All who share humbly in pondering over the secret of physical events are with you in spirit, and join in the admiration and love that bind us to Newton. What has happened since Newton in theoretical physics is the organic development of his ideas. Force became independent reality to Faraday, Maxwell, and Lorentz, and then went over into the conception of the field. The partial differential equation has taken the place of the ordinary differential equation used by Newton to express causality. Newton's absolute and fixed space has been converted by the theory of relativity into a physically vital frame. It is only in the quantum theory that Newton's differential method becomes inadequate, and indeed strict causality fails us. But the last word has not yet been said. May the spirit of Newton's method give us the power to restore unison between physical reality and the profoundest characteristic of Newton's teaching—strict causality."

THE Great Barrier Reef Committee of Australia, at present under the chairmanship of Prof. H. C. Richards of the University of Queensland, has for some years past promoted researches on the geology and biology of the Great Barrier Reef. It has now extended an invitation to Mr. F. A. Potts, of Trinity Hall, Cambridge, lecturer in zoology in the University, to carry out a programme of marine biological research under its auspices, and has announced its intention of placing at his disposal a sum not exceeding £1000 for the expenses of the expedition. This action on the part of Australian men of science offers a unique opportunity for a British investigation of some of the basal problems of tropical marine biology. It is proposed that, in addition to the leader, the party shall include experienced workers, one of whom would work on the direct connexion of the physico-chemical conditions and the phytoplankton, while a third would investigate the feeding mechanisms of the sedentary organisms which constitute the fauna of a coral reef. In the first case at least it is hoped that the observations will extend over an entire year. To carry out these proposals it is necessary to raise a substantial sum of money in addition to the original guarantee—at least another £1500 is required. To assist in the scientific organisation of the expedition an influential committee has been formed consisting of Sir Matthew Nathan, Ex-Governor of Queensland (chairman), Sir Joseph Cook, Sir Sidney Harmer, Sir Gerald Lenox Conyngham, Rear-Admiral Douglas, Prof. Stanley Gardiner, Dr. E. J. Allen, Dr. G. P. Bidder, and Mr. A. R. Hinks. It is very much to be desired that the investigation of such general problems, never before attempted in tropical seas, should be initiated by British men of science and the study of marine biology in its broader aspects fostered in Australia, which possesses such boundless marine wealth. The party will start in July and work in the neighbourhood of Cairns, Queensland.

THE recent announcement of the purchase of a large part of the Ashridge Estate by the Zoological Society of London will be welcomed by all scientific workers and lovers of Nature, for it is intended to establish there not only a large Zoological Park but also sanctuaries for British mammals, birds, insects, and the rarer chalk-loving plants. The site chosen is very happily situated on a sunny slope of the Chilterns about three miles south of Dunstable and near the picturesque village of Whipsnade. The total area comprises a little more than 400 acres, and includes every type of ground suitable for the objects which the Society has in view. The highest part of the property, which is well wooded, is more than 700 feet above sea-level, and at this point there is a large, well-drained plateau which is to be set aside for herds of deer, antelope, and other ungulates. On the west there is a steep descent into the valley, and it is here that terraces will be made for the larger carnivores, with deep ditches to separate them from each other and the visiting public. The development of the new Zoo will necessarily be slow, and for the present it will be used solely as a sanatorium for any animals which need a rest and change of air from the gardens at Regent's Park.

THERE is much work to be done before a start can be made on any scheme of development of the Zoological Society's newly acquired property. An artesian well will have to be sunk to ensure a good supply of water, and electric power will be needed for pumping, heating, and lighting. Dwelling-houses for the staff and administrative offices must be erected, while the whole area under consideration must be enclosed by a ring fence. At present, friendly negotiations are proceeding with the local authorities concerning certain rights which they hold over a portion of the land. The results of these negotiations will probably be incorporated in a private Act of Parliament, and until an agreement is reached on all the points under discussion, nothing definite in the way of development will be put in hand.

PROF. A. S. EDDINGTON'S tenth and last Gifford Lecture in the University of Edinburgh on Friday, Mar. 18, was on science and mysticism. Granted, he said in the concluding part of the lecture, that physical science has delimited its scope so as to leave a background which we are invited to fill with a reality of spiritual import, we have yet to face a difficult criticism. "Here," says science, "I have left you a domain in which I shall not interfere. I grant that you have some kind of approach to it through the self-knowledge of consciousness, so that it is not necessarily a domain of pure agnosticism. But have you any orderly system of inquiry into this domain comparable to the system of science? Have I any reason to regard the current religious interpretation of it as more than muddle-headed romancing?" Prof. Eddington declared himself unable satisfactorily to answer this question. In science, he said, we often have convictions as to the right solution which we have never been able to justify, and even that strict logician, the pure mathematician, reluctantly allows himself some prejudgments. Why is it that we attach so much truth and importance to the values determined by the mind, unless they are reflexions of mind of an Absolute Valuer? How can that mystic unity with the world, experienced in exceptional moments, continue to feed the soul in the sordid routine of life, unless we can approach the World-Spirit in the midst of our cares and duties in that relationship of spirit to spirit symbolised in the name of the Father?

AN appropriate, pleasing, and sympathetic ceremony was held on Mar. 15 at the Albert Dock Hospital, London, when the Minister of Health, the Right Hon. Mr. Neville Chamberlain, unveiled a memorial plaque to the late Sir Patrick Manson, the 'father' of tropical medicine, in the very ward in which he, with the efficient aid of the Seamen's Hospital Society, established the clinical teaching of tropical medicine some twenty-eight years ago. Sir Arthur Clarke, the chairman of the Seamen's Hospital Society, in introducing the Minister of Health, referred to the close association of Manson, the Chamberlain family, and his Society, in the firm belief that this family association might continue. Mr. Chamberlain, whose speech was permeated with great breadth of vision, emphasised the bearing of the main discoveries of tropical medicine on the trend of medical science as a whole, and in doing so showed remarkable familiarity, not only with the technical side, but also with the personal attributes of the subject of his discourse. His comparison of the historic association of Manson and Ross with that of Darwin and Wallace received general approbation as a singularly apt allusion. His familiarity with this department of medicine and his evident keenness and enthusiasm form a sure indication that the Minister of Health is alive to the paramount importance of tropical medicine in the Empire's affairs. Dr. G. C. Low, the senior physician, in proposing a vote of thanks to the Minister of Health, laid special emphasis on the persistence of Manson, ably backed by Mr. Joseph Chamberlain, in face of official and professional opposition to his schemes. Prof. R. T. Leiper, in seconding this vote, paid a special tribute to the personality of Sir Patrick Manson as portrayed in the recently published account of his life and to his genius in stimulating and encouraging research.

Water-finding apparatus has been on the market for many years, but our attention has only recently been directed to official tests carried out in India by the Department of Agriculture, Bombay, and described in the department's Bulletin No. 72 of 1915, revised in 1925. In this Dr. H. H. Mann and Mr. D. L. Sahasrabuddhe detail work done with two forms of water-finder manufactured in England, the mechanism of which is either secret or not very clearly described, but both act by the horizontal deflexion of a magnetic needle set in the magnetic meridian when placed directly above a flowing stream of underground water. Certain coils of wire are arranged in a chamber below the balanced needle, and these have no external connexions or batteries attached. The theory appears to be that a current is induced in the coils by earth-currents following the path of least resistance through water channels. The indications are of variable strength and show some indefinite diurnal range; when over a stream the magnet has been found to swing through as many as 20° to east or west with a slow irregular motion, taking perhaps half an hour to complete an oscillation. The observations were carried out in the Trap rocks of the Deccan, where the whole water-supply is from wells, and 40 per cent. of the wells sunk by native cultivators are said to be failures. All the cases cited of wells sunk in places found by the apparatus appear to have been successful. The results seem to satisfy the Bombay Department of Agriculture, and reference is made to equally satisfactory results obtained by Mr. S. B. Hudlikar, the Indore State geologist, and by Mr. G. B. Brooks in Queensland. The detection and measurement of earth currents would appear to be a useful field of research, and much might be expected from the use of electrical refinements made available since the inventions referred to in this paragraph. It is not impossible that investigations in this direction would throw light on the physical basis of dowsing.

Mr. Emil Hatschek discussed rigidity and other anomalies in colloidal solutions in his Friday evening discourse delivered at the Royal Institution on Mar. 18. The study of the viscosity of colloidal solutions by means of the capillary instrument was begun by Thomas Graham. Investigations by later observers using the same method revealed anomalies. Definitive attempts to elucidate the problem, made by Prof. W. R. Hess and by Mr. Hatschek independently, established the fact that the viscosity of colloidal solutions, unlike that of normal liquids, is not independent of the velocity gradient, but varies with it. The variation is the same in all solutions so far studied: the viscosity decreases with increasing gradient and approaches or reaches a constant value, while with decreasing gradient it grows asymptotically. A possible and widely accepted explanation of the anomalous viscosity is that colloidal solutions possess rigidity. It can be demonstrated mathematically that a liquid possessing rigidity would have a variable viscosity. Rigidity in many of the colloidal solutions can be demonstrated, and the modulus can be measured by very delicate apparatus. In most cases it increases with age; in all solutions examined rigidity disappears on warming to about 40°, but returns in varying degrees on cooling. Since rigid solutions, unlike normal liquids, can be deformed, they show double refraction when sheared. Suggestions put forward to account for these anomalies amount in general to assumptions of special structures in these liquids, of an order of magnitude larger than molecular, but modelled on the shape of the molecule. Such explanations are, however, inadequate on account of the extreme chemical diversity of the substances which exhibit anomaly. Furthermore, variable viscosity is a property also of coarse suspensions of nearly spherical particles in indifferent normal liquids, which do not arrange themselves into any ordered structures. The peculiar properties of colloidal solutions make them transitional systems possessing properties of both the liquid and solid state.

Mr. Ormsby-Gore, in his lecture on Mar. 7 on Nigeria before the Royal Geographical Society, laid stress on the success which has followed the British policy in Northern Nigeria of governing so far as possible through the emirates and the native administrations. The greatest disruptive power in West Africa had proved to be the introduction of English law and English judicial procedure. In the northern provinces, justice has been administered in the native courts, and the ancient system of taxation has been continued, 50 per cent. of the tax, soon to be increased to something like 70 per cent., being returned to the native treasury. In Southern Nigeria, however, owing to the absence of any organised chieftainship and the more primitive character of the social organisation, British rule has been more direct, and it has been necessary to build up native courts and native treasuries. Mr. Ormsby-Gore showed well-founded anxiety in speaking of the possible disruptive effects of the projected rapid development of the railway system. An administration which is both well aware of the dangers of detribalisation and sympathetically and intelligently concerned in the maintenance of native institutions as a means of discipline should be well able to cope with the situation. Nigeria should have less cause to fear than other parts of Africa.

The British Non-Ferrous Metals Research Association has arranged an exhibit at the Science Museum, South Kensington, which is designed to show the assistance given to British metal industries by the research and auxiliary services of an industrial research organisation. The Association carries on a twofold service: first, in the prosecution of research work either of a fundamental and scientific character or of direct practical utility; and secondly, in maintaining a highly organised information service which operates for the general benefit of the Association as a whole and to meet the specific needs of individual member firms. The present exhibit is concerned chiefly with eight of the Association's researches, chosen as typical from among eighteen major investigations at present in progress, and gives some idea of the scope of each piece of work and the progress which has so far been made. Investigations on the following subjects are illustrated: Effect of impurities up to 1 per cent. on the properties of copper; gases in copper castings; brass casting (the surface and internal soundness of ingots); the jointing of metals; die-casting alloys (brass and bronze alloys and aluminium alloys); 'wiped' plumbers' joints; spectroscopic assay of zinc; and atmospheric corrosion. Information is also displayed illustrating the Association's administrative, library, and information services, with some examples of the work normally carried out in these departments.

At a meeting of the Royal Society of Edinburgh held on Mar. 14, the following were elected fellows: Dr. D. A. Allan, Newcastle-upon-Tyne; Mr. J. Barnett, Edinburgh; Mr. S. E. Bastow, Edinburgh; Mr. D. L. Bryce, Horley; Prof. H. G. Cannon, Sheffield; Dr. T. M. Finlay, Edinburgh; Dr. A. W. Greenwood, Edinburgh; Dr. J. M. Gulland, Oxford; Dr. H. S. Holden, Nottingham; Mr. O. D. Hunt, Glasgow; Dr. J. Hyslop, Glasgow; John Alexander Inglis of Auchindinny and Redhall; Prof. E. T. Jones, Glasgow; Dr. W. P. Kennedy, Edinburgh; Prof. J. M. M. Kerr, Glasgow; Dr. C. G. Lambie, Edinburgh; Dr. D. M'Intyre, Glasgow; Dr. Mohamed Reda Madwar, Helwan; Dr. F. N. K. Menzies, London; Prof. T. P. Noble, Bankok; Mr. W. J. Owen, Melbourne; Mr. C. Patterson, Edinburgh; Dr. H. H. Read, Edinburgh; Mr. J. E. Richey, Edinburgh; Dr. I. Sandeman, Edinburgh; Dr. R. Schlapp, Edinburgh; Prof. F. W. Sharpley, Dhanbad, India; Prof. E. Shearer, Edinburgh; Dr. C. W. Wardlaw, Glasgow; Mr. C. B. Boog Watson, Edinburgh; Dr. W. T. H. Williamson, Edinburgh.

The French Association des Anatomistes has arranged to hold its meeting in London on April 11-13 in co-operation with the Anatomical Society of Great Britain and Ireland. The congress will meet at University College. About 150 members of the two societies are expected, and as the French society includes members coming from several of the European countries, namely, Belgium, Italy, France, Holland, Switzerland, Spain, Portugal, Poland, and Czechoslovakia, the congress promises to be an international one such as hitherto has not been held in Great Britain. On the evening of April 11 a conversazione will be held at University College. One of the most interesting features of the meeting will be the reception by Mr. Henry S. Wellcome in his Historical Medical Museum on Tuesday, April 12, at 8 P.M. On the following evening a dinner will be held at King's College. Arrangements have been made for the members of the congress to visit Cambridge as the guests of Prof. Wilson. There will be a trade exhibit dealing with scientific appliances and other technical equipment for anatomical study.

In the *Metropolitan-Vickers Gazette* for February, details are given of the important power station of the Bristol Corporation which will be constructed at Portishead on the Bristol Channel about seven miles from Bristol. As it has received the approval of the Electricity Commissioners, it is doubtless the forerunner of many similar large power stations. The ultimate capacity of the station is 280,000 kilowatts, and provision will be made to transmit the whole output at a pressure of 33,000 volts to the corporation power station in Bristol. The first section of the station will be equipped with two turbines of 20,000 kilowatts capacity, each driving a three-phase 50-cycle alternator generating at 11,000 volts. The generating plant operates at the high speed of 3000 revolutions per minute and the boiler pressure will be 325 lb. per square inch. These increasing speeds and pressures show the trend of modern practice. Another point of interest is the method of obtaining cooling water for the condensers. Circulating water will be taken from the Bristol Channel, and 35,000 gallons of water per minute will be required for the first two sets. Since the tidal fluctuation is exceptional, involving a variation of about 50 feet in water level, it has been decided to place the condensers at such a level that the full syphon action will be obtained at all states of the tide. This effects a large saving in the power required for operating the cooling water system.

Arrangements are being made for a repetition at Easter of the tour in the Dordogne organised by Prof. Patrick Geddes for the purpose of visiting the rock paintings and carvings of the palæolithic caves of the area and for regional survey work. The tour will last from April 15 until 30. The first week will be spent at Les Eyzies and will be devoted to archæological study under M. Peyrony. For the remainder of the time M. Paul Réclus will conduct regional survey work in a series of expeditions in the country around Domme. Particulars as to route, cost, etc., may be obtained from Miss Moya Jowitt, 33 Gordon Square, London, W.C.1.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—A chief veterinary inspector under the Surrey County Council—The Clerk of the County Council, County Hall, Kingston-upon-Thames (Mar. 31). A senior demonstrator of pathology in St. Bartholomew's Medical College—The Dean, St. Bartholomew's Medical College, St. Bartholomew's Hospital, E.C.1 (April 6). An officer-in-charge of the wood preservation section of the Forest Research Institute, Dehra Dun, India—The Secretary to the High Commissioner for India, 42 Grosvenor Gardens, S.W.1 (April 8). A head of the textile department of the Municipal Technical College, Bolton—The Director of Education, Nelson Square, Bolton (April 8). An assistant in the Forest Products Research Laboratory, for work on the identification and structure of wood, and an assistant in the Entomology sub-section of the same laboratory—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1 (April 9). An assistant government chemist for forest research in the Federated Malay States—The Private Secretary (Appointments), Colonial Office, 38 Old Queen Street, S.W.1 (April 14). An assistant to the pathologist of the Manchester Committee on Cancer, for laboratory work and the supervision of the maintenance of animals—The Chairman of the Manchester Committee on Cancer, 1 Mount Street, Manchester (April 16). Demonstrators (men or women) in the departments of chemistry and physics of Bedford College for Women—The Secretary, Bedford College for Women, Regent's Park, N.W.1 (May 7). A professor of natural history at University College, Galway—The Secretary (May 14). A professor of mathematics and a reader in physics in the University of Dacca, Bengal—The Registrar, University of Dacca, East Bengal (May 31). A Ramsay Memorial fellow for chemical research—The Secretary, Ramsay Memorial Fellowship Trust, University College, Gower Street, W.C.1 (June 6). A cancer research fellow in the department of experimental pathology and cancer research of the University of Leeds—The Clerk to the Senate, The University, Leeds. A woman lecturer in biology and nature study at the Norwich Training College—The Principal. A lecturer in geography at the Lincoln Training College—The Principal. A senior biology mistress at the Cheltenham Ladies' College—The Principal. A head of the chemical department of the Leicester College of Technology—The Registrar. A junior assistant in the Experimental Stores department of the Experimental Station, Porton — The Commandant.

Our Astronomical Column.

COMETS.—Two further observations of Stearns's comet have come to hand, as follows; they are for the equinox of 1927·0:

U.T.	R.A.	S. Decl.	Observer.	Place.
Mar. 14·08354	$15^h\ 15^m\ 6{\cdot}6^s$	6° 11′ 54″	Möller	Copenhagen.
15·15479	15 14 46·5	5 51 26	Vinter-Hansen Struve	Babelsberg.

The following orbit by Mr. L. E. Cunningham has been telegraphed from Harvard and distributed by the I.A.U. Bureau :

T 1927 Sept. 6·200 U.T.

$$\left.\begin{array}{lrr}\omega & 48^\circ & 59' \\ \Omega & 214 & 54 \\ i & 92 & 29\end{array}\right\}1927{\cdot}0$$

log q 0·50406

It would appear that some error has been made in telegraphing Ω, as the above orbit fails to represent the observations. A correction of about + 14′·6, making it 215° 8′·6 is indicated.

Mr. Moller has computed the following ephemeris from the uncorrected orbit; it is for 0^h, and the R.A. is likely to need a correction of about $+1^m$:

	R.A.	Decl.		R.A.	N. Decl.
Mar. 20.	$15^h\ 11^m\ 36^s$	4° 6′ S.	Apr. 13.	$14^h\ 53^m\ 52^s$	5° 24′
28.	15 7 8	1 9 S.	21.	14 45 32	8 49
Apr. 5.	15 1 8	2 3 N.	29.	14 36 23	12 10

The orbit is still very uncertain, owing to the slow motion and the shortness of the observed arc. If it is approximately correct the brightness is likely to increase considerably, but the comet will not attain naked-eye visibility.

The following positions of comet Pons-Winnecke are by Prof. G. van Biesbroeck :

U.T.	R.A. 1927·0.	N. Decl.	Mag.
Feb. 27·26042	$14^h\ 6^m\ 58{\cdot}69^s$	24° 28′ 17″·5	17
Mar. 3·43021	14 12 20·42	25 45 23 ·7	16·5
4·30822	14 13 24·72	26 2 29 ·5	16·2

FIREBALL OF MAR. 1.—Mr. W. F. Denning writes: "There was a splendid meteor on Feb. 25 just before midnight, and another, scarcely less luminous and striking, appeared on Mar. 1, at 5.44 A.M. The latter has, however, received little comment for, like many others which pass almost unrecorded, it came at a time when people generally are asleep. The meteor was described by an observer at Staines as a huge green star with a tail of fire. At Peckham it was seen as a large green fireball with a vivid light and leaving a shower of sparks. There are six observations, including reports from Winchester and Hoddeston, Herts. The radiant point appears to have been in the Lynx or northern region of Gemini, and the height of the meteor 72 to 50 miles above the region of Hertford to near St. Valery on the French coast. One observer estimated the apparent diameter of the head of the meteor as a half that of the moon's diameter; another thought it equal in size to a tennis ball, but all agree as to the great intensity of its light and the startling effect of its sudden apparition."

PROPER MOTIONS OF FAINT STARS.—There have been many recent determinations of the proper motions of faint stars by photography. In *Mon. Not. Roy. Astr. Soc.* for Dec. 1926, Dr. W. M. Smart analyses the proper motions of 3029 stars from photographs taken with the Sheepshanks equatorial at Cambridge at an interval of twenty-two years. The apices of the two drifts are found as : Drift I, α 88°, $\delta - 12°$; Drift II, α 289°, $\delta - 73°$. The latter δ is farther south than other determinations. The position of the solar apex is found as α 273°·2, $\delta + 43°{\cdot}6$. The R.A. is in good accord with the accepted value, the declination is some 14° farther north. The speed of the solar motion agrees closely with that found by Prof. Eddington from the much brighter stars in Boss's Catalogue.

Dr. H. Knox Shaw gives in *Mon. Not.* for Jan. 1927 a list of 17 large proper motions of faint stars in the Kapteyn selected areas. They are all more than 10″ a century: the largest amounts to 50″ a century, being that of a 15th magnitude star in R.A. $5^h\ 9^m\ 44^s$, N. decl. 60° 24′ (1900). It should be worth while to examine this star for parallax. It is probably an extreme dwarf.

Research Items.

CHINESE FRESCOES FROM HONAN.—Frescoes described as "the most important works of art that have ever come out of China" have recently been acquired by the Museum of the University of Philadelphia and are figured and discussed by Miss Helen E. Fernald in the *Museum Journal* (Philadelphia), vol. 17, No. 3. Up till a few years ago it was thought that the great frescoes of the temples and palaces of the T'ang dynasty extolled in Chinese literature had long perished. Various expeditions to Turfan and the borders of western China had, however, discovered fragments of paintings unquestionably of this period, but showing signs of provincial workmanship. In 1925 the Museum acquired five mural paintings from a cave temple in Honan; but these, and others which appeared in America and Europe at the same time, were merely single figures cut from the walls and without definite data. They did no more than prove that early frescoes did still exist in China. Three panels have now been acquired which belong together and form part of an enormous picture which must have been at least forty feet long and twenty-five feet high, and of which the composition can be reconstructed with some probability. Of the three panels, the central represents Sakyamuni seated on a dais in the *pādmasana* position, with legs crossed and each foot resting on the opposite leg, sole uppermost. The left panel represents Avalokiteśvara, the Bhodhisattva of Mercy, seated in European fashion. The right-hand panel shows an important personage in robes befitting an emperor approaching the Buddha throne accompanied by a delicate female figure and followed by an official-looking individual. Two demon kings in fantastic armour are in the background. The three frescoes evidently represent three of the most important sections of a Paradise scene, such as appears again and again on the walls of caves of the Thousand Buddhas. Stylistic and other considerations assign the paintings to the latter part of the T'ang dynasty, about 845 A.D. or possibly thirty years later, and suggest as their possible source a mountain monastery of Honan.

THE ARCHÆOLOGY OF THE VALLEY OF MEXICO.—The interesting problem of the evidence for the pre-Aztec culture found beneath the lava bed of the Valley of Mexico is discussed by Mrs. Zelia Nuttal in a contribution to the *Proceedings of the American Philosophical Society*, vol. 65, No. 4. So long ago as 1861, attention was directed to fragments of pottery from beneath the lava bed, and clay heads of an archaic type have been on exhibit in the Trocadero Museum, Paris, since 1881; but their significance was not realised until investigations and excavations under the lava bed and the discovery of similar archaic heads and pottery elsewhere had revealed the existence in Mexico Valley of an archaic culture, of which an extension has since been discovered in Guatemala. It would appear from the results of recent investigation that Mexico Valley in remote antiquity was inhabited for a long period by a race which made pottery, modelled figurines, used flaked obsidian knives, and built a truncated structure faced with unworked stones. This structure was surrounded by lava flow at a period variously estimated at from 2000 to 5000 years ago. This area was the home of the *teozintl*, from which maize developed. The survivors of the catastrophe due to flood and the volcanic eruption seem to have drifted southward and to have established themselves in Guatemala, where they remained for a long period, developing the Maya and Mexican calendar. From this site they would appear to have been driven out by a catastrophe, possibly volcanic, possibly a famine due to a plague of grasshoppers, and migrated northward, carrying maize to Central America, and settled again in Mexico Valley. This hypothetical reconstruction would serve to confirm the legends and throw light on the connexion between the Maya and Aztec people, establishing the unity of their culture and their common origin.

NORWEGIAN PLANKTON INVESTIGATIONS.—The first food eaten by many young fish immediately after the absorption of the yolk consists of pelagic diatoms, and it has been suggested that the fluctuations in the supply of cod from year to year may depend on the amount of plankton food available for the young when they start to feed. Accordingly, in 1922-1925, investigations were carried out in Norway to ascertain the yearly variations in the quantity of plankton. In a preliminary report on the "Quantitative Investigations of Plankton at Lofoten, March-April 1922-1924" (*Rep. Norweg. Fish. Mar. Invest.*, vol. 3, No. 7, 1926), Birgithe Ruud traces the spring outbursts of the coastal diatoms and their connexion with the transport of dissolved nutrient matter in the snow water from the land. It is shown that the date of the spring flowering of the plankton at Lofoten depends upon the melting of the snow, for each year it follows immediately after the snow has begun to melt. The increase in the number of diatoms starts near the land and gradually spreads to offshore waters, the flowering being heralded from place to place by a lowering of the temperature and decrease in salinity, both of which are due to the increasing amount of fresh water from the snow melting on the land, on which the quantity of the developing plankton depends.

THE GROWTH OF HORNS.—The Swiss Society of Natural Sciences has published as part of its sixty-third volume (1926, pp. 1-180) an elaborate monograph by Dr. J. Ulrich Duerst on the horns of the Bovidæ (*Denkschriften der Schweizerischen Naturforschenden Gesellschaft*, Band 63. "Das Horn der Cavicornia. Seine Entstehungsursache, seine Entwicklung, Gestaltung und Einwirkung auf den Schädel der horntragenden Wiederkäuer." Zürich). Dr. Duerst holds that horn formation is primary, and that this has secondarily determined the development of a bone-core; evidence in support of this view is drawn from several examples of cutaneous horns containing a bony nodule (true os cornu). On the other hand, he denies the presence of a separate os cornu as a normal condition, but nevertheless is of opinion, from developmental evidence, that the bone-core is not a true outgrowth or apophysis but an epiphysis, which is from the beginning joined to the frontal bone. In this connexion Dr. Duerst refers at some length to the views of Gadow (*Proc. Zool. Soc.*, 1902), and although he does not consider in any detail the general problem of the relation of horns to the antlers of the Cervidæ, he appears to believe that the latter have been independently evolved. Variations in the form and structure of horns are explained in terms of their growth; of special interest are the account of the phenomenon of the shedding of juvenile horns in different species of the Bovidæ with numerous illustrated examples, and the discussion of the special case of the American prongbuck (Antilocapra), which periodically sheds its horns. An important concluding section of the monograph deals with the influence of horns on the form of the skull, a subject which

Dr. Duerst treats largely from the mechanical point of view. There are eighty figures and a full bibliography.

Insect Control in the United States.—The United States Bureau of Entomology represents the largest organisation in existence for the control of injurious insects. Under the direction of its chief, Dr. L. O. Howard, it has reached a high standard of efficiency and scientific attainment. Dr. Howard's report for the year ending June 30, 1926, has recently come to hand, and forms a record of a very wide range of activities. Among the many problems in hand, the Japanese beetle comes in for a big share of attention, and its investigation now forms a separate section of the Bureau. The perennial campaign against the Gipsy and Brown-tail moths has not been relaxed, and more than three and a half million parasites of the former insect have been liberated during the period under review. The extreme drought of 1924 extended through the cotton-growing season of 1925 and resulted in but a light infestation of the boll weevil, which has, in consequence, restricted the experimental work. The practicability of aeroplane dusting for controlling this insect has been fully borne out, and there are now several companies operating aeroplane dusting on a very extensive scale. Malaria investigations by the Bureau, and also in co-operation with other bodies, have been actively pursued. The identification of the blood imbibed by mosquitoes has led to the determination of the host relationships and preferences of various species, while a considerable amount of research has been carried out with reference to arsenical and other compounds as larvicides. Among other problems, those relating to forest insects, apiculture, and a general insect-pest survey are also reported on.

Polychæta from the Philippines.—Most of the Polychæta collected by the *Albatross* in the neighbourhood of the Philippine Islands during 1907–1909 have already been described, but in an additional paper recently published (*Bull. U.S. Nat. Mus.*, vol. 6, part 2) A. L. Treadwell makes some further records, including descriptions of one new genus and three new species. Monorchos, the new genus, is of the family Sabellariidæ, and is distinguished from allied genera by possessing only a single row of paleæ, internal to which is a series of hooks arranged in a V-shaped manner. The genotype, *M. philippinensis* n.s., is known only from a number of anterior portions brought up from 805 fathoms between Siquijor and Bohol Islands. Of the other new species, *Lætmonice nitida* n.s. is separated from *L. producta* Grube, as described by M'Intosh from the *Challenger* collections, chiefly by the form of the chætæ and by the absence of a felt covering. Two partially complete specimens are also regarded as a new species, which has been named *Eupanthalis evanida*. Some heteronereids obtained at Mindanao are thought to be *Nereis masalacensis* Grube, and a description of them is given.

Linkage in Garden Peas.—The inheritance of fifteen characters in the garden pea—the classical material of Mendel's experiments—has been studied by Miss Sverdrup (*Jour. of Genetics*, vol. 17, No. 3) on a large scale. A new mutation appeared in the experiments, having narrow leaflets frequently alternate and various flower-changes, including a narrow, pointed standard and sterile carpels. It is recessive in inheritance when the pollen is used in crosses. The main purpose of the experiments was to determine the linkages between factors. In certain cases it was found that the backcross involving two pairs of characters gave different linkage values from the F_2; or, in other words, when the cross is of the form $DR \times DR$, the crossing-over frequency is different from that of the cross $DD \times RR$. Such discrepancies in the coupling and repulsion values have been observed by other investigators in Primula, maize, and morning glories, but the explanation is not apparent. The fifteen factors of Pisum are found to fall into four linkage groups and five other independent factors, thus making nine independently assorting groups, whereas there are only seven pairs of chromosomes. One pair of the chromosomes is found to have attached satellites, which Nawaschin has shown in Crepis to be independent in the prophase of mitosis. It is suggested that possibly the structure of the chromosomes may be more flexible in Pisum than in Drosophila, where an exact correspondence has been shown between the linkage groups and the chromosome number.

Irrawaddy Delta Air Survey.—On the Burma Forest Department needing large-scale maps of the forest areas of the Irrawaddy delta, arrangements were made to undertake an air survey, since the district, which consists of densely wooded alluvial plains, did not lend itself to any other form of mapping. Progress by land is laborious, especially during high spring tides, when much of the country is submerged. The sandy sea beaches and the banks of creeks at low water afford the only lines of communication except by water. An account of the survey is given by Major C. G. Lewis in *Records of the Survey of India*, 21, 1. The area originally surveyed was about one thousand square miles, to which another 440 square miles was afterwards added. Ground control for the air survey was difficult to obtain owing to the height of the trees, which rendered useless even masts of 100 feet in length. The procedure eventually adopted was traversing along the sea beaches and triangulation along the main streams. The country was then cut up into five or six sections, each enclosed by a circuit of fixed points. The photography was begun in February and finished early in April 1924, when a total of 3795 plates had been exposed at an average elevation of 9400 feet. It is estimated that a ground survey of the delta would have occupied a party of thirty surveyors at least three years, at double the cost. The disadvantages of the air survey are that minor creeks are often obscured by overhanging trees and cannot be traced in detail on the photographs, and that it was seldom possible to photograph the coast-line at low tide, with a result that the low-tide line and many sandbanks were not surveyed.

The Echelon Structure of Japanese Volcanoes.—Under this title Sakuhei Fujiwhara presents a remarkable analysis of the distribution of volcanoes in Japan (*Gerlands Beiträge z. Geophysik*, 1927, p. 1). He defines a shear as positive when the stresses applied make a right-handed system, and as negative when they make a left-handed system, and shows by experiment that a positive shear gives a series of compression cracks in positive echelon and a complementary series of tension cracks in negative echelon. Applying this principle, it is clear that the sense of shear that has been applied to a region can be determined if the echelon cracks can be interpreted as due to tension or compression. A survey of all the Japanese volcanic lines shows that with one minor exception they are arranged in positive echelons, and that the volcanoes themselves have developed mainly along the axes of anticlines, that is, along lines controlled by compression. Thus it is deduced that the Japanese Islands are affected by a positive regional shear acting to the south-west on the Pacific side and to the north-east on the Asiatic side. The San Francisco earthquake revealed a corresponding movement on the other side of the Pacific, namely, a north-west movement of the ocean floor relative to North America. As a result of a recent study of the volcanoes of Central America, Sapper has shown that they too form a good positive echelon. It thus appears that the bed of the North Pacific is making a counter-clockwise rotation relative to the surrounding lands, and that the seismic generating force in California and Japan may be due to this rotation. No suggestion is given as to the possible origin of such a movement, but the recognition of the latter is itself a contribution to tectonic geology and geophysics of fundamental importance. The paper should be carefully studied by all who are interested in these subjects.

THE MAGNETIC MOMENT OF HYDROGEN.—On the older quantum theory, atomic hydrogen should be paramagnetic, and the moment of the atom should be the unit Bohr magneton. Any large departure from this value might have an important bearing on the new undulatory mechanics and on the idea of a spinning electron, and its experimental determination is thus a matter of considerable importance. This has now been done by T. E. Phipps and J. B. Taylor (*Phys. Rev.*, **29**, p. 309; 1927), using a modified form of the well-known apparatus of Stern and Gerlach. A pencil of hydrogen atoms was allowed to diffuse from a discharge tube through a series of narrow glass slits into a highly evacuated chamber. It was there passed through an intense inhomogeneous magnetic field, in which the atoms were orientated and deflected. They were finally registered as a simple pattern of blue lines when they impinged on and reduced a white film of molybdenum trioxide. Within the experimental error of 10 per cent., which arises largely from uncertainty as to the velocity of the atomic rays, the moment of the atom is one Bohr magneton. Active hydrogen from a tungsten filament proved to be less satisfactory, and no result could be obtained with the product of the action of ultra-violet light on a mixture of mercury vapour with hydrogen.

HIGH VOLTAGE OVERHEAD TRANSMISSION.—In the January issue of *AEG Progress*, the journal of the Allgemeine Elektricitäts Gesellschaft of Berlin, there is a timely article on high tension overhead lines. One of the troubles which electrical engineers have to overcome when using very high electrical pressures is to avoid the production of brush discharges from the line—the so-called corona discharge—as when these discharges appear there is a sudden increase in the power lost in the line and a consequent lowering of efficiency. It is known that the larger the conductors the higher is the limiting voltage at which the corona appears. This has been taken advantage of by using aluminium instead of copper for the conductors, as the larger sizes of these conductors make higher voltages possible. The A. E. G. manufactures special hollow conductors for very high voltage cables. It is pointed out that it is advisable when erecting overhead lines to make them of such size that they can, if necessary, be used for considerably higher voltages. At 220 kilovolts the diameter of the conductors must be at least 2·5 cm. if corona losses are to be avoided. It is stated that the manufacture of hollow conductors presents little difficulty. For the erection of these large wires, special tackling equipment is described. Caterpillar tractors are used to haul the necessary heavy loads over uneven ground. In the front page a photograph is given of part of a polyphase transmission line as it crosses the Main between Neuenahr and Rheinau. It is described as being for 380 kilovolt working.

THE SCATTERING OF X-RAYS.—In a recent number of the *Physikalische Zeitschrift* (No. 3, 1927) Prof. P. Debye has reprinted an important article on the scattering of X-rays by amorphous bodies, originally published by him in the *Journal of the Massachusetts Institute*. Both he and Prof. W. H. Keesom have pointed out that the interference rings obtained with liquids—similar to those produced in the powder method of crystal analysis—cannot be due entirely to the individual molecules acting as small crystals, since the patterns are very similar for different substances, and are also obtained with a liquefied monatomic gas, where the existence of a polyatomic molecule is unlikely. The principal maximum in the interference pattern has consequently been attributed to superposition of radiation scattered from molecules acting as units. If this part of the intensity of the scattered rays could be predicted as a function of the angle made with the primary ray, the residual effect, which would arise from radiation scattered by the component atoms, might give, for example, very direct information about the distance apart of the latter. Prof. Debye has given an elegant theoretical treatment for the simple case of a gas the molecule of which is a uniform sphere, and has shown that although even then the unknown Laue scattering factor has to be introduced, interference phenomena are to be expected. To a first approximation, the gross action of the molecules is proportional to the ratio of their total volume to that of the vessel in which they are contained, and so can be allowed for ideally by experimenting at different pressures. The interference pattern for a simple diatomic molecule has been worked out on similar lines, and a graphical illustration given of how it would be expected to vary with the density of the gas, the internal atomic contribution and aggregate molecular contribution being readily distinguished.

THE FORMATION OF GOLD FROM MERCURY.—A detailed account of the experiments by which the authors claim to have demonstrated the conversion of mercury into gold is given by Miethe and Stammreich in a recent issue of the *Zeitschrift für anorganische Chemie* (vol. 158, p. 185, 1926). They describe the method used in the purification of the mercury, but without detail, stating that this is unnecessary when tests show the absence of gold in the product. The mercury is distilled to a small residue, which is then treated with nitric acid and the residual gold melted with borax in a small porcelain dish. The treatment of the mercury in various ways is then described. Several types of mercury lamps are represented, although not in exact detail. The yield of gold in various experiments was very variable. In some cases no gold was found. The discharge in mercury vapour gave no gold. In a mercury turbine interrupter gold was produced and the copper electrodes after the experiments contained more gold in the outer layers than was present at the beginning. In other types of interrupters no gold was formed. Discharges between electrodes and mercury in a gas yielded negative results. Discharges between mercury and solid electrodes under paraffin oil yielded gold. The majority of the experiments gave negative results, but a connexion between positive results and the particular kind of discharge used is found. The results of other experimenters are discussed, and the conclusion is drawn that these are really in favour of the views of Miethe and Stammreich. Theoretical criticisms of their work are not regarded seriously by the latter, since they start from assumptions different from those which they themselves consider possible. They emphasise that the matter is purely an experimental problem.

The Hydrography and Geology of Umbria.[1]

In the volume before us, the Royal Italian Geological Survey has published, as the latest of its classic "Memorie descrittive," Dr. Bernardino Lotti's comprehensive work on that region which comprises the present Province of Perugia. A distinguished member of that Survey for forty-seven years, and latterly, down to the time of his retirement, director of the same, Dr. Lotti, as field geologist and chief engineer of the Mining Department, has contributed to the quarterly *Bollettino* of that Survey and other scientific periodicals as many as 200 papers, chiefly on his special sphere of central Italy, including his standard memoirs on Tuscany and the Island of Elba.

The volume was only recently completed in Dr. Lotti's retirement, in which he has now reached his eightieth year. It covers more than three hundred pages of text, with two maps and three photographic plates, and is composed of the following sections: hydrography, orography, stratigraphy, tectonic, and additional chapters on lignite deposits, mineral springs, and landslides, to which last-named the formations of Umbria are particularly liable. The stratigraphical section comprises the successive formations from the Upper Trias (Rhætian) as the oldest Umbrian Mesozoic series, to Lias, Jura, and Cretaceous, and to the Tertiary and Quaternary. The orographic and tectonic sections describe consecutively the anticlinal, longitudinally aligned, parallel Umbrian mountain and hill ranges between the mainly Tertiary Apennines and the predominantly Mesozoic Subapennines, with the synclinal depressions and valleys between them. These are the effect of earth-movements during the Miocene uprise and erosion, the tropical, marine, and lacustrine Pliocene subsidence, and the Pleistocene and more recent Quaternary uprise, which lifted the marine, estuarine, and fluvial gravels and conglomerates to heights of 300 to 1000 metres above the present sea-level. These phenomena correspond to those in the same periods in the Alps, where the Pleistocene was a period of glaciation.

The outstanding physiographic feature of Umbria is the great central Tiber basin, which in its middle or Umbrian course of eighty miles extends north to south from Città di Castello to the plain below Perugia and Assisi and thence to Todi, with the subsidiary basin of Foligno and Spoleto, and the ancient, now separated basin of Terni, the principal feeders of which are the rivers Nera and Velino. On the subject of these great ancient Umbrian, as well as the Arno basins of Tuscany, the present writer published in the *Scottish Geographical Magazine* for May and June 1919 a paper, "The Ancient Sea and Lake Basins of Central Italy," and Dr. Lotti's work deals with the Umbrian basins on similar lines.

Another outstanding feature of Umbrian hydrography are the famous Terni Marble Falls at the junction of the Velino with the Nera just above that city, the height of the vertical column—the greatest of any waterfall in Italy south of the Alps—being 160 metres and its width 20 metres. The mean volume of the Velino, of 50 cubic metres per second, is capable of producing potential energy of 80,000 horse-power, largely utilised for hydro-electric purposes. Of these historic falls Dr. Lotti's work gives a beautiful photographic view, taken by Alinari of Florence, and here reproduced (Fig. 1). The falls, which were described in the present writer's paper quoted above, are formed by three cascades, the principal upper and the two lower ones, as shown in the illustration. The large volume of the Velino is derived, besides its own drainage area in the Sybelline Mountains, from its four affluents rising in the Sabine Hills. The Marble Falls owe their name to the thick crust of travertine which covers the underlying Jurassic limestone rocks and has the appearance of polished marble.

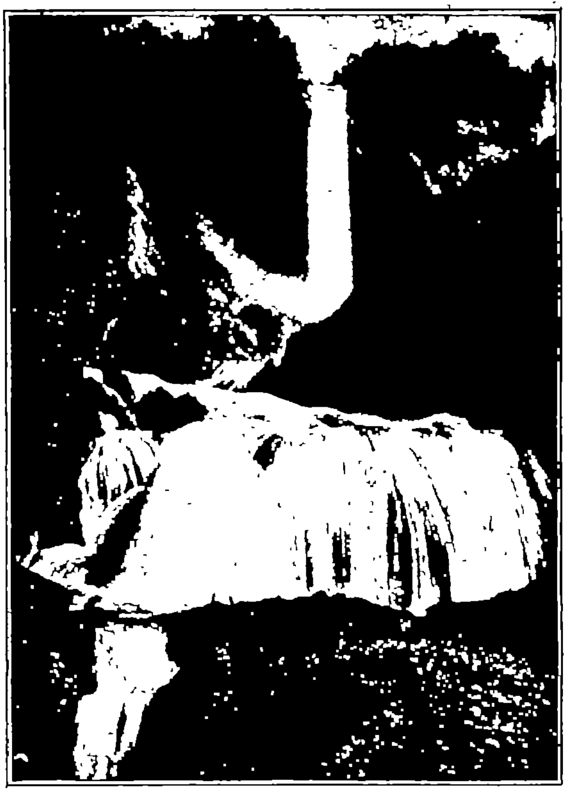

Fig. 1.—The Terni Marble Falls, Umbria.

C. Du Riche Preller.

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[1] Descrizione geologica dell' Umbria. Per B. Lotti. Pubblicata per cura del R. Ufficio Geologico. (Memorie descrittive della Carta Geologica d' Italia, Vol. 21.) Pp. 320. (Roma: Provveditore generale dello Stato Libreria, 1926.) 45 lire.

Palæolithic Man in Scotland.

Until the summer of 1926 no indubitable trace of palæolithic man had been found in Scotland, if the Azilian remains of the west coast and the Tardenoisian flints scattered throughout the country be regarded as belonging to an intermediate period between the old and new stone ages. The persistent absence of palæolithic evidences has generally been ascribed either to the presence of an ice-sheet covering Scotland at a date long after such Arctic conditions had disappeared in England and Wales and to the consequent non-presence of human beings, or to the erasure of traces of palæolithic humanity deposited in a period of interglacial mildness by a later recrudescence of the ice-sheet.

During three summer months of 1926, excavations, superintended by Mr. James E. Cree, were carried out, by means of a generous grant from the Royal Society of London, in undisturbed caves in the valley of Allt nan Uamh, near Inchnadamph in Sutherland, in close proximity to the 'Bone Cave' which yielded such excellent faunistic results at the hands of Dr. Horne and the late Dr. Benjamin Peach in 1889. A preliminary report on the results of the first season's excavations was communicated by the committee responsible for the administration of the grant, Mr. J. Graham Callander, Mr. James E. Cree, and Dr. James Ritchie, to the Society of Antiquaries of Scotland at its meeting on Feb. 14.

Of the four caves in which work was carried out, the Reindeer Cave proved to be the most interesting. It contained two bone-bearing deposits, an upper cave-earth, and a lower slightly rounded gravel. The cave-earth contained many bones of still existing species of animals as well as of bears, and two human skeletons or parts of skeletons, one of which, a dolicocephalic skull, had been definitely interred, the first formal interment yet recorded from a Scottish cave. The gravel was remarkable for the vast numbers of shed and broken antlers of young reindeer which were scattered throughout the deposit, a short distance of about twenty feet yielding remains of more than four hundred individual reindeer. Associated with these were remains of other members of an Arctic fauna, and indubitable traces of man were revealed by a simple reindeer horn implement, by humanly cut and scratched reindeer antlers, by rude attempts at engraving, and by fragments of charcoal.

The evidence points to the re-sorting of the reindeer deposit in the cave by a stream, probably of seasonal melt-water, which flowed along the margin or off the surface of a valley glacier the surface of which stood about the level of the caves, 200 feet above the present bed of the stream. Further, the geological evidence, the nature of the fauna, and the state of fossilisation of the bones, all show that the deposit belongs to one of the periods of the Upper Palæolithic series, belonging to Magdalenian or earlier times. Lack of artefacts of cultural significance prevents a more definite conclusion in the meantime.

A further discovery of great interest was made in a large cave, the presence of which was unsuspected until access was gained through the clearing of a narrow vertical chimney 10 feet in depth. In the glacial silt which filled this cave almost to the roof were found bones of reindeer and arctic animals, including remains of the extinct cave-bear and arctic fox, neither of which has hitherto been found in Scotland. The geological evidence suggests that this association represents an arctic fauna present in Scotland in a period of interglacial mildness, prior to the last considerable recrudescence of the ice, and long preceding the valley glaciers of the final ice-epoch. No trace of this interglacial fauna has been definitely determined hitherto in northern Britain.

In concluding his presentation of the report on behalf of the Committee, Dr. Ritchie pointed out that further evidence is desirable, particularly as regards the cultural stage of the palæolithic people and as to the members of the cave-bear interglacial fauna, and that with the view of obtaining such evidence, excavation is to be continued during the present summer.

University and Educational Intelligence.

CAMBRIDGE.—P. Hall has been elected to a fellowship at King's College. A. F. H. Ward, Jesus College, has been elected to the Amy Mary Preston Read Scholarship.

The University Appointments Board reports that 396 men were placed in appointments in the past year, including 135 educational appointments, 80 manufacturing and technical appointments, 68 administrative appointments in commerce and industry, 51 in colonial administration, 19 in agriculture and forestry, and 7 in overseas railways, public works departments and surveys.

It is proposed to confer the title of Registrary Emeritus upon Dr. J. N. Keynes in recognition of his great services to the University during the fifteen years of his registraryship.

LONDON.—The first course of the series of Gow Lectures on the colloid chemistry of the rubber industry will be given under the auspices of the University by Dr. E. A. Hauser of Frankfort-on-Main, at University College, London (Gower Street, W.C.1) during the first fortnight in May. Full particulars of these lectures will be published later.

MANCHESTER.—Prof. H. S. Raper has been appointed Dean of the Medical School as from July next.

Among those on whom it is proposed to confer honorary degrees on Founders' Day, May 18, are Dr. C. S. Myers, Director of the National Institute of Industrial Psychology, and Prof. Richard Willstätter, formerly professor of chemistry in the University of Munich and Nobel prizeman, who are to receive the degree of D.Sc.

The Hill Prize in bio-chemistry has been awarded to Mr. Eric Boyland.

OXFORD.—A research fellowship in medical science of the value of £200 a year has been established in memory of Dr. Gustave Isidore Schorstein, of Christ Church, Assistant Physician to the London Hospital. Candidates must be graduate members of the University, whether men or women, who hold a registrable medical qualification and are less than thirty-five years of age. Fellows are to be elected, without examination, by the Board of the Faculty of Medicine. The fellowships are tenable for two years, but may be extended by the Board for one further year.

ST. ANDREWS.—A benefactor, who desires his name to be withheld, has offered the sum of £100,000 in appreciation of the progress made in development of the university. Of this sum, £40,000 is to be set aside for the purpose of founding residential entrance scholarships, each of the annual value of £100. These scholarships are to be confined to men students of the United College, and the condition is attached that the holders must reside in an official residence in St. Andrews. Five such scholarships will be open for competition each year, and the first appointments will be made before the beginning of next academical year. Towards the cost of the new Residence Hall for men students, £29,000 has been allocated; the sum of £8000 is to be devoted to the improvement of the University Chapel, and the remainder of the gift, amounting to £23,000, is left at the disposal of the University Court.

An additional contribution of £12,000 on behalf of the Residence Hall has been announced, and Lord Inchcape has given £5000 for the same purpose. Together with other gifts and the £20,000 awarded by the Carnegie Trust as part of the quinquennial allocation to the University, the funds at the disposal of the Court for the building of the residence amount to £70,000. It has been resolved to proceed at once with the scheme.

THE committee of the Leplay House Tours Association is arranging to take two groups of students and others on to the Continent during the coming Easter vacation. One party will go to the Auvergne, a centre of interest to geographers, geologists, and botanists, and the other to Dalmatia, a visit of special interest to students of archæology, history, and sociology. Full darticulars can be obtained from Miss Margaret E. Tatton, Leplay House, 65 Belgrave Road, London, S.W.1.

Calendar of Discovery and Invention.

March 27, 1827.—A hundred years ago, on Mar. 27, 1827, Darwin, then just eighteen years of age and a medical student at Edinburgh, contributed to the Edinburgh Plinian Society a paper on the larvæ of the Flustra or sea-mat, one of the Polyzoa.

March 27, 1895.—After making known the discovery of argon, Ramsay, through a suggestion of Sir Henry Miers, made experiments with the mineral cleveite, which it was thought would contain a compound of argon. From these experiments he was led to the isolation of helium, detected by Lockyer in the sun in 1868, but hitherto unknown on the earth. This discovery was made known on Mar. 27, 1895, at the annual meeting of the Chemical Society, the *Transactions* of which contain Ramsay's account of his investigations.

March 27, 1899.—The first wireless message across the English Channel was sent on Mar. 27, 1899. With an aerial erected on Dover Town Hall, signals were sent to Wimereux, near Boulogne, 32 miles distant, this being the record distance for wireless telegraphy up to that time.

March 29, 1810.—The modern printing machine can be traced back to Friedrich König, a printer of Leipzig. König visited England in 1806, and four years later, on Mar. 29, 1810, took out the first of four patents for printing machines in which he employed revolving cylinders. The *Times* was first printed by König's machines on Nov. 14, 1814, while the first book printed by machinery was Blumenbach's "Physiology."

March 31, 1795.—The hydraulic press so extensively used to-day was described by Bramah in his patent of Mar. 31, 1795, and his demonstration apparatus is preserved in working condition at the Science Museum, South Kensington. Pascal, 150 years previously, had, however, stated the principle of the machine. If a vessel, he said, had two openings, one a hundred times as large as the other, and if each be supplied with a piston which fit it exactly, then a man pushing the small piston will equilibrate that of 100 men pushing the larger piston.

March 31, 1889.—Commenced on Jan. 28, 1887, the Eiffel Tower in Paris, the highest structure in the world, was completed on Mar. 31, 1889. Its height is 300 metres and its weight 6875 tons.

April 1, 1823.—On April 1, 1823, the Treasury requested the opinion of the Royal Society on the merits and utility of a plan submitted by Babbage for applying machinery to the purpose of calculating and printing mathematical tables. This referred to the "difference engine" invented by Babbage in 1812. Its construction was authorised in 1823, suspended in 1833, and abandoned in 1842, after the Government had provided about £17,000 and Babbage had expended some £6000 of his own. This and many other calculating machines are now to be seen in the mathematical collections at the Science Museum, South Kensington.

April 2, 1799.—For more than seven centuries the home of Benedictine monks, the Priory of Saint Martin-des-Champs, Paris, in 1790 was appropriated by the French nation, and on April 2, 1799, became the home of the Conservatôire des Arts et Métiers, instituted by law on Oct. 10, 1794.

April 2, 1845.—The photographic study of the sun may be said to have been begun in 1858 with De la Rue's 'photo-heliograph,' but thirteen years before that, on April 2, 1845, Foucault and Fizeau obtained a daguerreotype of the sun which was reproduced in his "Popular Astronomy" by Arago, at whose suggestion the experiment was made.

E. C. S.

Societies and Academies.

LONDON.

Royal Society, Mar. 17.—**W. L. Bragg** and **J. West**: The structure of certain silicates. In a number of compounds the oxygen atoms are arranged in one of the forms of closest packing, the atoms of metal or silicon being inserted into this oxygen assemblage and causing only a slight distortion of its ideal arrangement. Typical examples are the compounds Al_2O_3, $BeAl_2O_4$, $MgAl_2O_4$, Mg_2SiO_4, $MgCaSiO_4$, $(MgOH)_2Mg_3(SiO_4)_2$, Al_2SiO_5 (kyanite). In the diffraction of X-rays by these crystals, which are often characterised by low symmetry and large unit cell, the simple pattern produced by the oxygen arrangement is evident, superimposed upon the pattern produced by the crystal as a whole. Other silicates are based upon more complicated arrangements of oxygen atoms, but these atoms appear in all cases to play a highly important part in determining the structure.

W. A. Wooster: The analysis of beams of moving charged particles by a magnetic field. The intensity distribution in the line produced by a magnetic field acting on a beam of homogeneous particles is determined (*a*) for a source of particles which is infinitely narrow, and (*b*) for sources of various finite widths. The conditions under which the analysis of moving charged particles is most favourably carried out are derived from this structure of the lines. The method can be applied to the determination of the velocity distribution of particles passing through thin sheets of matter.

J. F. Spencer and **E. M. John**: The magnetic susceptibility of some binary alloys. The magnetic susceptibility of the pure metals gold, silver, lead, tin, bismuth, aluminium, and cadmium, and a complete series of binary alloys of lead with gold, silver, and tin; tin with aluminium, bismuth, gold, and cadmium; and gold with cadmium have been measured by means of a Curie balance. The susceptibility-composition curves indicate the existence of some intermetallic compounds which have not previously been recognised, for example, Al_4Sn_2, Ag_5Pb_2, and Sn_4Bi_3; they confirm the existence of some other compounds, for example, Pb_3Au_2, $AuSn_2$, $AuCd_3$. The curves and measurements show that the alloy of lead and silver containing 29 per cent. of lead is comparatively strongly paramagnetic, that of lead and gold containing 94 per cent. lead is strongly diamagnetic, and the aluminium-tin alloy containing 75 per cent. of tin is also strongly diamagnetic. The susceptibilities of the lead-tin alloys, where compounds are not formed, may be calculated by the mixture rule.

H. T. Flint and **J. W. Fisher**: A contribution to modern ideas on the quantum theory. An account is given of the four-dimensional aspect of de Broglie's phase wave, followed by a suggestion for the inclusion of quantum phenomena into the general theory of relativity by the introduction of a four-vector, to complete the current four-vector of electrodynamics, of which the divergence does not vanish. This leads by a simple assumption to a generalised form of Shrodinger's wave equation.

Royal Meteorological Society, Feb. 16.—**J. Glasspoole**: The variability of average monthly rainfall throughout the year. The variability of the monthly averages for the thirty-five years, 1881–1915, has been circulated for some 550 stations in two ways. In (1) the range has been used, *i.e.* the difference between the largest and smallest monthly averages. It varies from 1 inch at stations along the east coast and in central England, to 9·8 inches at both Glenquoich, in the western Highlands of Scotland, and

Seathwaite, in the English Lake District. The equation $R = -0{\cdot}14 + 19M + 41M^2$ represents fairly closely the variation of the range (R) with the mean rainfall per day (M) in all parts of the British Isles. In (2) the monthly averages have been expressed as 'mean rainfalls per day.' The mean deviation of these amounts, as a percentage departure from the mean for the twelve monthly values, varies from 11 per cent. in central England to more than 25 per cent. in Dartmoor, the Lake District, parts of Wales, and the western Highlands of Scotland. The distribution in this case presents features unlike that of the map of the average annual rainfall.—**L. F. Richardson** and **Denis Proctor**: Diffusion over distances ranging from 3 km. to 86 km. This paper describes the way in which air is scattered and mixed by the eddies in the wind. In order that the wandering of a piece of air may be observed, the air must have some mark carried with it; small free balloons have been used and also volcano ash. The statistics of the observed scatter may be of interest in connexion with factory smoke and town planning. The rate of diffusion has been observed by various authors for air masses ranging in size from a few metres to 1000 kilometres, and comparison of their results shows that Fick's law does not describe atmospheric diffusion.

CAMBRIDGE.

Philosophical Society, Feb. 28.—**G. C. Steward**: On Herschel's condition and the optical cosine law. Sir John Herschel investigated the condition which would ensure the vanishing of spherical aberration for the region, upon the axis of an optical system, in the neighbourhood of two conjugate axial points, themselves free from aberration; but Herschel's condition applies only to first order, or primary, aberration, *i.e.* to aberration depending upon the cube of the inclination of the ray to the axis of symmetry. Abbe, later, gave a more general condition which is shown to imply the stationariness of spherical aberrations of *all* orders. A geometrical proof is given of a very general theorem recently published by T. Smith under the name of the optical cosine law. This law is valid in the presence of any combination of the geometrical aberrations, as well for a symmetrical as for an unsymmetrical optical system.

PARIS.

Academy of Sciences, Feb. 14.—**Maurice Hamy**: A particular case of diffraction of solar images.—**P. Villard**: The chemical actions of radiations. A description of experiments in which two halves of the same plate are exposed to ordinary light and to X-rays, with a discussion of the meaning of the results obtained. Contrary to the view generally admitted, the properties of a latent image vary with the frequency of the radiation to which the plate has been submitted.—**de Sparre**: Remarks on a recent note published by H. Sugot. A re-assertion of priority.—Prof. John Townsend was elected a *correspondant* for the section of physics in succession to Pierre Weiss, elected non-resident member.—**Bertrand Gambier**: Surfaces having a ds^2 of Liouville and their closed geodesics.—**P. Noaillon**: An isolated non-critical singular point of a harmonic function.—**R. Gasse**: A special class of equations of the form $s = f(x, y, z, p, q)$.—**Octave Onicescu**: Adjusting an aggregate of values, and its applications to the representation of functions by series of functions and to integral equations.—**Hasso Harlen**: The logical paradox in the theory of ensembles.—**P. Dupont**: Calculation of the frictional forces on the profiles of wings.—**Pierre Dive**: The impossibility of an ellipsoidal stratification of a heterogeneous fluid in rotation.—**R. Wavre**: Figures of equilibrium, the stratification of the planets and the equation of the first species.—**Gaston Dupouy**: A direct reading apparatus for the measurement of magnetic fields. A gaussmeter. A crystal of siderose (iron carbonate) is mounted so that the geometrical axis of rotation of the apparatus is perpendicular to the plane containing the ternary axis of the crystal and the direction of the lines of force. The couple produced by the magnetic field is balanced by the torsion of a wire or spiral spring. The apparatus is graduated by direct comparison with a flux meter of the usual type. Measurements can be made very quickly, but with the drawback that there is a correction for temperature.—**A. Cotton**: Remarks on the preceding communication.—**Pierre Chevenard**: The anomaly of the internal friction of reversible ferronickels.—**A. P. Bigot**: Some anhydrous silicas containing clay. The composition of ochres.—**Paul Gaubert**: The dehydration and hydration of some platinocyanides.—**J. Thoulet**: Densimetry in the Tyrrhenian Sea.—**Besson**: Comparative observations of the light radiation at the sea coast and in the interior.—**Jean des Cilleuls**: The phytoplankton of the Thouet, a tributary of the Loire.—**A. Maige**: Observations on the various modes of digestion of starch grains in plant cells. The two modes of digestion of starch grains, peripheral or internal, are related to the presence or absence of a plastial crust, possessing an adhesive property for the amylase.—**Volmar** and **Samdahl**: Kirondrine, the bitter and toxic principle of Kirondro seeds (*Perriera madagascariensis*). A crystalline substance has been isolated from Kirondro seeds (0·75 per cent. of seed). It does not appear to be an alkaloid, neither does it give the reactions of a glucoside. Its chemical composition is being investigated.—**A. Gruvel**: Raising *Salmo Pallaryi* in Morocco.—**Mlle. F. Coupin**: The index of cerebral value in infancy in the anthropoids.—**M.** and **Mme. Lapicque**: Concentration of the cellular juices in the higher fungi.—**L. Bounoure**: Has ovular supermaturation an influence on the origin of the primary gonocytes in *Rana temporaria*?—**Edouard Fischer**: The upper limit of distribution of various organisms in very calm water.—**A. Blanchetière**: The composition of the peptones. Description of a method for separating and determining peptides and diacipiperazines, and determinations of the proportions of the latter in various specimens of commercial peptones.—**E. Aurel**, **L. Genevois**, and **R. Wurmser**: The apparent potential of solutions of reducing sugars.—**Paul Hauduroy**: Diphtheric toxins giving rise to a diphtherimorph bacillus. A specimen of diphtheric toxin, preserved in the dark for two years, contained filtrable bacilli from which, by a series of plate cultures, visible organisms were obtained possessing the morphological characters of the diphtheria bacillus; but *without pathogenic action* (guinea-pig).—**R. Sazerac**, **Hirosi Nakamura**, and **Mme. M. Kitchevatz**: The action of bismuth on hæmorragic icterus. Bismuth, as sodium tartarobismuthate, possesses a remarkable preventive action towards infection by *Spirochæta icterohæmorragiæ* in the guinea-pig, and also has marked curative action on the evolution of the disease caused by this organism.

ROME.

Royal Academy of the Lincei, Jan. 2.—**V. Volterra**: Biological fluctuations.—**C. Somigliana**: The relations existing between the geodetic constants and the values of gravity. Development of Pizzetti's expression for gravity on the surface of the ellipsoid of rotation leads to the conclusion that there exists a homogeneous linear relationship between any three values of gravity on such a surface. The same expression gives rise to a biquadratic equation which determines the eccentricity as a function of any three values of gravity and of their corresponding latitudes.—U. Cisotti: A noteworthy exception to the Kutta-Joukowski theorem.—F. Millosevich: The corundum rocks of Val Sessera.—L. Petri: The method of applying Wood's light in investigations on vegetable pathology. Attention is directed to the existence of a peculiar luminogenous substance, which appears to be present in all living vegetable tissues, even in potato tubers, although the photograms of the green tissues are by far the more luminescent. The crude alcoholic extract of chlorophyll gives a photogram with a wine-red fluorescence, whereas the photogram of chlorophyll-free leaf tissue is only moderately fluorescent. Dilute sulphuric acid does not modify the luminogenic properties, and the substance in question diffuses rapidly by capillarity into filter paper.—S. Baglioni, L. Bracaloni, and A. Galamini: Physiological action of alcohol. Variations in glucohæmia and alcoholæmia resulting from ingestion of alcoholic liquors and of saccharose (ii). The results of experiments on human beings reveal a connexion between glucohæmic and alcoholæmic variations which appears to support, in part at least, the hypothesis advanced by Ford and recently maintained by Serono, that sugar ultimately undergoes alcoholic scission in the organism.—F. De Carli: Anhydrous borates of silver, barium, and zinc. The results of measurements of the temperature of devitrification of systems composed of boric anhydride and silver oxide, barium oxide, and zinc oxide respectively indicate the existence of anhydrous borates having the formulæ: $Ag_2O, 4B_2O_3$; BaO, B_2O_3; $BaO, 2B_2O_3$; $BaO, 3B_2O_3$; $BaO, 4B_2O_3$; $2ZnO, B_2O_3$, and ZnO, B_2O_3.—C. Jucci: Heredity of the metabolic type in silkworms. Larval development in reciprocal crosses between two races of *Bombyx mori*.—E. Benedetti: The telencephalon of the triton. Contribution to the comparative study of the central nervous system of amphibia.

Official Publications Received.

BRITISH.

British Legion. Annual Report and Accounts, 1926, January 1st to September 30th. Pp. 87+4 plates. (London.)

Leeds University. Report to the Worshipful Company of Clothworkers of the City of London of the Advisory Committee on the Departments of Textile Industries and Colour Chemistry and Dyeing, during the Session 1925–26. Pp. 11. (Leeds.)

The National Institute of Industrial Psychology. Annual Report and Statement of Accounts for the Year ended December 31st, 1926. Pp. 20. (London.)

Proceedings of the Royal Society of Edinburgh, Session 1926–1927. Vol. 47, Part 1, No 1: Further Experiments with the Swing Ball-and-Tube Flowmeter. By J. H. Awbery and Dr. Ezer Griffiths. Pp. 10. 1s. Vol. 47, Part 1, No. 2: The Theory of Persymmetric Determinants from 1894 to 1919. By Sir Thomas Muir. Pp. 11-23. 2s. Vol. 47, Part 1, No. 3: The Law of Blackening of the Photographic Plate at Low Densities (Second Paper). By E. A. Baker. Pp. 24-31. 1s. 6d. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

Records of the Indian Museum. Vol. 28, Part 3: Zoological Results of a Tour in the Far East; The Tanaidacea and Isopoda of Tale Sap. By Dr. Chas. Chilton. Pp 178-185. (Calcutta.)

Philosophical Transactions of the Royal Society of London. Series B, Vol. 214 (B 417): The Development of the Calcareous Test of *Echinus miliaris*. By Dr. Isabella Gordon. Pp. 259-312. Series B, Vol. 215, (B 426): The Development of the Calcareous Test of *Echinocardium cordatum*. By Dr. Isabella Gordon. Pp. 255-313. (London: Harrison and Sons, Ltd.)

The Physical Society of London. List of Officers and Fellows. Pp. 27. (London: Imperial College of Science.)

Ministry of Agriculture and Fisheries. Second Progress Report of the Foot-and-Mouth Disease Research Committee. Pp. 117. (London: H.M. Stationery Office.) 2s. net.

The British Research Association for the Woollen and Worsted Industries. Publication No. 74: Exhibition of Scientific and Practical Research Work, Opened by the Earl of Balfour at the Science Museum, South Kensington, 1st March 1927. Pp. 21. (Headingley, Leeds.)

Journal of the Royal Statistical Society. Vol. 90, Part 1, 1927. Pp. x+224. (London.) 7s. 6d.

Survey of India. General Report, 1925 to 1926, from 1st October 1925 to 30th September 1926. Pp. viii+51+iii+3 maps. 1 rupee; 1s. 9d. Map Publication and Office Work, 1925 to 1926, from 1st April 1925 to 31st March 1926. Pp. viii+23+5 maps. 1 rupee, 1s. 9d. (Calcutta.)

Bothalia: a Record of Contributions from the National Herbarium, Union of South Africa, Pretoria. Vol. 2, Part 1A: A Preliminary Study of the South African Rust Fungi. By Ethel M. Doidge. Pp. 228+6 plates. (Pretoria: Government Printing and Stationery Office.) 7s. 6d.

Botanical Survey of South Africa. Memoir No. 9: A Preliminary List of the known Poisonous Plants found in South Africa. By Dr. E. P. Phillips. Pp. 30+14 plates. (Pretoria: Government Printing and Stationery Office.) 2s. 6d.

Union of South Africa: Department of Agriculture. Reprint No. 64, 1926: Diseases of Virginian Tobacco in South Africa. By Dr. H. S. Moore. Pp. 30. (Pretoria: Government Printing and Stationery Office.) 3d.

Dominion of Canada. Report of the Department of Mines for the Fiscal Year ending March 31, 1926. (No. 2116.) Pp. v+77. (Ottawa: F. A. Acland.) 20 cents.

Canada. Department of Mines: Geological Survey. Economic Geology Series, No. 2: Talc Deposits of Canada. By M. E. Wilson. (No. 2091.) Pp. v+149 (14 plates). 25 cents. Memoir 149, No. 130 Geological Series: Placer and Vein Gold Deposits of Barkerville, Cariboo District, British Columbia. By W. A. Johnston and W. L. Uglow. (No. 2096.) Pp. iii+246 (15 plates). 40 cents. Memoir 150, No. 131 Geological Series: Whitehorse District, Yukon. By W. E. Cockfield and A. H. Bell. (No. 2101.) Pp. ii+63 (8 plates). 20 cents. (Ottawa: F. A. Acland.)

Canada. Department of Mines: Victoria Memorial Museum. Museum Bulletin No. 45, Biological Series No. 12: List of Quaternary and Tertiary Diatomaceæ from Deposits of Southern Canada. By C. S. Boyer. (No. 2102.) Pp. 26. 10 cents. (Ottawa: F. A. Acland.)

FOREIGN.

Ministry of Finance, Egypt: Coastguards and Fisheries Service. Résumé of the Report on the Fisheries of Egypt for the Year 1925. By El Miralai Ahmed Bey Fouad. Translated from the Arabic. Pp. viii+84. (Cairo: Government Publications Office.) 5 P.T.

Ministry of Public Works, Egypt: Physical Department. Interpretation of Correlation Coefficients. By S. Krichewsky. (Physical Department Paper No. 22.) Pp. 14. (Cairo: Government Publications Office.) 5 P.T.

Ministry of Finance: Survey of Egypt. The Phosphate Deposits in Egypt. By Dr. W. F. Hume. (Survey of Egypt Paper No. 41.) Pp. iii+20+7 plates. (Cairo: Government Publications Office.) 10 P.T.

R. Università degli Studi di Perugia. Annali della Facoltà di Medicina e Chirurgia. (Bollettino dell' Accademia Medico-Chirurgica di Perugia.) Vol. 29, Anno 1926, Serie 5, Vol. 4. Pp 296+147. (Milano: Società Anonima Istituto Editoriale Scientifico.)

Anales del Museo Nacional de Historia Natural Bernardino Rivadavia, Buenos Aires. Tomo 33. Pp. vii+369. (Buenos Aires.)

Almanaque del Ministerio de Agricultura para el año 1927, preparado por la Sección Biblioteca con la cooperación de las Reparticiones del Ministerio. Año 2. Pp. 560. (Buenos Aires.) 1 peso.

Koninklijk Nederlandsch Meteorologisch Instituut. No. 106A: Ergebnisse aerologischer Beobachtungen. 12, 1924. Pp. iv.+40. 2.50 fl. No. 103: Seismische Registrierungen in De Bilt. 11, 1923. Pp. x+59. 1 fl. (Utrecht: Kemink en Zoon.)

Department of Commerce: Bureau of Standards. Scientific Papers of the Bureau of Standards, No. 534: Effect of Concentrated Loads on the Length of Measuring Tapes. By Lewis V. Judson. Pp. 385-393. 10 cents. Scientific Papers of the Bureau of Standards, No. 540: Measurement of Surface Tension. By N. Ernest Dorsey. Pp. 563-596. 15 cents. Scientific Papers of the Bureau of Standards, No. 542: Electric Field of a Charged Wire and a Slotted Cylindrical Conductor. By Chester Snow. Pp. 631-646. 10 cents. (Washington, D.C.: Government Printing Office.)

CATALOGUES.

Canadiana: Catalogue of Books, Manuscripts, Engravings and Maps, relating to the Canadian Empire; also a Selection on Arctic Discovery, including Alaska, Yukon, Greenland, Spitzbergen, Kamtschatka and Northern Pacific Ocean. (No. 493.) Pp. 42. (London: Francis Edwards.)

A Catalogue of Important and Rare Books on Zoology, Geology and Palæontology; including a Fine Collection of Original Water-Colour Drawings. (No. 407.) Pp 136. (London: Bernard Quaritch, Ltd.) 1s.

Catalogue of Astronomical and Optical Instruments. Publication No. 4. Pp. 30. (Newcastle-on-Tyne: Sir Howard Grubb, Parsons and Co.)

Diary of Societies.

SATURDAY, MARCH 26.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (South-Eastern District Meeting) (at Guildhall, Rochester), at 11 A.M.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (South Midland District Meeting) (at Leighton Buzzard), at 11 A.M.—H. J. Barnes: Waterworks.—B. H. Robjant: Housing Schemes.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (North-Eastern District Meeting) (at Town Hall, South Shields), at 2.15.—J. Reid: Estimation of Storm Water Discharge.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Yorkshire and North-Western Districts) (at Town Hall, Manchester), at 2.30.—R. Bruce and others: Discussion on Manchester and District Joint Town Planning Report.

Geologists' Association (at Museum of Practical Geology), at 2.30.—Demonstrations:—Fossil Plants from the Coal Measures, by Dr. R. Crookall.—Goniatite Zones of the Millstone Grit of Central Lancashire, by S. W. Hester.—Fossils from the Neighbourhood of Leighton Buzzard, by J. Pringle.

Royal Institution of Great Britain, at 3.—Sir Ernest Rutherford: The Alpha Rays and their Application to Atomic Structure (2).

North of England Institute of Mining and Mechanical Engineers (at Neville Hall, Newcastle-upon-Tyne), at 3.—R. White: The Ventilation of a Pyrites Mine, with special reference to Fire-fighting, Safety and Rescue Work.—Papers open for Further Discussion:—Dry Cleaning of Coal, by J. S. Carson; Conveyors and Conveying Systems, by W. Britton.

Hull Association of Engineers (at Municipal Technical College, Hull), at 7.15.—A. R. Clemitson: Water Tube Boilers and Pulverised Fuel.

MONDAY, March 28.

Royal Society of Edinburgh, at 4.30.—Dr. H. H. Read: The Igneous and Metamorphic History of Cromar, Deeside, Aberdeenshire.—A. Calder: The Rôle of Inbreeding in the Development of the Clydesdale Breed of Horses.—Prof. W. Peddie: Magnetism and Temperature in Crystals.—Miss W. J. Smith: After Images of Coloured Sources.—Y. Tamura: The Effects of Implantation upon Ovarian Grafts in the Male Mouse.

Institute of Actuaries, at 5.—C. F. Trustam: On a New Method of Calculating Model Office Reserves.

Royal College of Surgeons of England, at 5.—C. E. Shattock: Demonstration of Veins and Lymphatic Vessels.

Institution of Electrical Engineers (North-Eastern Centre) (at Literary and Philosophical Society, Newcastle-upon-Tyne), at 7.—W. B. Whitney, C. E. R. Bruce, and E. B. Wedmore: The Number of Tests required to establish the Rupturing Capacity of an Oil Circuit-Breaker.

Institution of Mechanical Engineers, at 7.—Sir John E. Thornycroft: Torpedo Boats and their Machinery (Annual Lecture).

Royal Society of Arts, at 8.—G. I. Finch: Some Industrial Applications of Electrothermics (Cantor Lectures) (3).

Royal Society of Medicine (Odontology Section), at 8.—D. Stewart: Some Aspects of the Innervation of the Teeth.—T. B. Layton: Osteomyelitis of the Maxilla in Scarlet Fever.

TUESDAY, March 29.

Royal Society of Arts (Dominion and Colonial Meeting), at 4.30.—J. H. Oldham: Tendencies in African Native Education.

Royal Aeronautical Society, at 5.—Annual General Meeting.

Royal College of Physicians of London, at 5.—Sir Charles Briscoe, Bart.: The Muscular Mechanism of Respiration and its Disorders (Lumleian Lectures) (3).

Royal Institution of Great Britain, at 5.15.—Prof. J. W. Cobb: Some Properties of Coke (1).

Hull Chemical and Engineering Society (at Grey Street, Hull), at 7.45.—R. B Foster: Works Filtration.

WEDNESDAY, March 30.

Faraday Society (at Chemical Society), at 3.—Dr. W. H. J. Vernon: The Second Experimental Report to the Atmospheric Corrosion Research Committee of the British Non-Ferrous Metals Research Association.

Newcomen Society for the Study of the History of Engineering and Technology (at 17 Fleet Street), at 5.30.—Dr. A. Raistrick: Notes on Lead Mining and Smelting in West Yorkshire.

Liverpool Engineering Society (at 9 The Temple, Liverpool), at 6.—Dr A. McCance: Properties of Steel at High Superheated Temperatures.

Institution of Civil Engineers (Students' Meeting), at 6.30.—V. F. Cornish: The London County Council Becontree Housing Estate.

Institution of Electrical Engineers (South Midland Centre) (at Birmingham University), at 7.—F. H. Clough: The Stability of Large Power Systems

Eugenics Society, at 8.

THURSDAY, March 31.

Royal Society, at 4.30.—Sir Robert Hadfield: Alloys of Iron and Manganese of Low Carbon Content.—Dr. E. Griffiths: The Thermal and Electrical Conductivity of a Single Crystal of Aluminium.—W. L. Webster. The Transverse Magneto-Resistance Effect in Single Crystals of Iron.—*To be read in title only*:—Prof. W. A. Bone, R. P. Fraser, and F. Witt: The Initial Stages of Gaseous Explosions. Part III. The Behaviour of an Equimolecular Methane-Oxygen Mixture when Fired with Sparks of Varying Intensities.—F. T. Meehan: The Expansion of Charcoal on Sorption of Carbon Dioxide.—J. F. Lennard-Jones and W. R. Cook: The Equation of State of a Gaseous Mixture.

Royal Institution of Great Britain, at 5.15.—H. J. E. Peake: The Beginnings and Early Spread of Agriculture (1).

Child-Study Society (at Royal Sanitary Institute), at 6.—Mrs. Leah Manning: American Ideals in Education.

Institution of Electrical Engineers, at 6.—W. McClelland: The Applications of Electricity in Warships.

Royal Aeronautical Society (at Royal Society of Arts), at 6.30.—Dr. E. G. Richardson: Recent Model Experiments in Aerodynamics.

Society of Chemical Industry (Manchester Section, jointly with North-Western Branch of Institution of Mechanical Engines) (at Engineers' Club, Manchester).—Dr. W. R. Ormandy: Lubrication.

FRIDAY, April 1.

Royal College of Surgeons of England, at 5.—Sir Arthur Keith: Demonstration of the Anatomy and Physiology of the Gall Bladder.

Society of Chemical Industry (Chemical Engineering Group, jointly with Institution of Mechanical Engineers) (at Institution of Mechanical Engineers), at 6.—A. G. Marshall and C. H. Barton: Lubricating Oils—Laboratory Tests in relation to Practical Results.

Institution of Civil Engineers, (Birmingham and District Association) (at Chamber of Commerce, Birmingham), at 6.—H. R. J. Burstall: The Testing of Heat Engines.

Society of Chemical Industry (Manchester Section) (Annual General Meeting) (at 16 St. Mary's Parsonage, Manchester), at 7.—Dr. W. Rosenhain: The Work of the National Physical Laboratory.

Institution of Locomotive Engineers (at Engineers' Club, Coventry Street, W), at 7.—A. M. Bell: Tare and Load compared in Modern Locomotives and Rolling Stock.

Institution of Mechanical Engineers (Informal Meeting), at 7.—Major A. W. Farrer: British Empire and Overseas Trade.

Royal Photographic Society of Great Britain, at 7.—Pictorial Group Meeting.

Photomicrographic Society (at 4 Fetter Lane), at 7.—E. Cuzner: Stereoscopic Photomicrography.

West of Scotland Iron and Steel Institute (at Royal Technical College, Glasgow), at 7.—Annual General Meeting.

Junior Institution of Engineers, at 7.30.—G. J. Hartley. Notes on the Production of Saltpetre.

Geologists' Association (at University College), at 7.30.—Dr. A. Kingsley Wells: The Geology of the Dolgelley District.

Philological Society (at University College), at 8.—N. B. Jopson: Judæo-Spanish Notes.

Royal Institution of Great Britain, at 9.—J. Allen Howe: The Stones of London.

SATURDAY, April 2.

Royal Institution of Great Britain, at 3.—Sir Ernest Rutherford: The Alpha Rays and their Application to Atomic Structure (3).

PUBLIC LECTURES.

SATURDAY, March 26.

Horniman Museum (Forest Hill), at 3.30.—M. A. Phillips: Wild Life in Meadow, Stream, and Wood.

SUNDAY, March 27.

Guildhouse (Eccleston Square), at 3.30.—Very Rev. Dr. J. H. Hertz (Chief Rabbi): Fundamental Ideals and Proclamations of Judaism.

WEDNESDAY, March 30.

Fulham Central Public Library, at 8.—M. C. Pink: The London Telephone Service.

THURSDAY, March 31.

Fulham Central Public Library, at 8.—S. C. Freeman: Flowers for London Gardens.

SUNDAY, April 3.

Guildhouse (Eccleston Square), at 3.30.—Prof. J. P. Bruce: Confucianism.

CONFERENCE.

March 29, 30, and 31.

Royal Microscopical Society (at Liverpool University).—Prof. C. O. Bannister: Demonstration of the Use of the Microscope in the Examination of Surface Structure of Metals and in the Detection of the various Platinum Metals in Silver Beads.—J. E. Barnard: Recent Advances in Medical Microscopy.—Conrad Beck: The Best Method of Illumination of Metallurgical Specimens with Vertical Illuminator.—Mrs. Bisbee: A Method for Demonstrating Certain Features in the Anatomy of Flat Worms.—Dr. W. B. Cooke and C. F. Hill: Pneumo-koniosis due to Asbestos Dust.—R. J. Daniel: Note on a Method of Staining and Clearing Muscular Systems of Crustacea.—I. S. Double: The Microscopic Characters of Certain Horizons of the British Chalk.—Prof. J. Bronte Gatenby: Golgi Apparatus, and Idiosome: a Critique of Parat's Vacuome Theory.—Prof. R. Ruggles Gates and Dr. J. Latter: Meiotic Phenomena in Lathræa.—H. Hurrell: The Ecology of Freshwater Polyzoa in East Anglia.—Dr R. J. Ludford: The Cytology of Secretions.—Dr. James A. Murray: Experiments in Stereo-Photomicrography.—Dr. Eric Ponder: The Diameter of the Red Cells of Man before and after Exercise.—Prof. W. Ramsden: Demonstration on Surface Tension.—J. Ross-Mackenzie: Causes and Correction of Cloudiness in Malted Liquors.—Dr. A. C. Thaysen and H. J. Bunker: Some Observations on the Microscopical Study of Deteriorated Fabrics from Early Egyptian Tombs.—Harold Wrighton: The Photomicrography of Metals.—J. E. Barnard, Conrad Beck, Dr. W. J. Elford, Dr. G. M. Findlay, Dr. J. E. McCartney, and John Smiles will take part in a discussion on Filterable Viruses and the Limits of Microscopic Visibility.

A Popular Lecture will be delivered on Thursday evening, March 31, at 8 P.M., in the Arts Theatre of the University by Prof. J. Arthur Thomson on The Microscopy of Everyday Life.

COMMEMORATION.

April 1.

Lister Centenary (at Glasgow).

CONGRESSES.

April 20 to 24.

Journées Médicales Marseillaises et Coloniales (at Marseilles).—Prof. Cantacuzène: The Rôle of the Streptococcus in the Etiology of Scarlet Fever.—Dr. Mayer: Recent Advances in the Treatment of Cancer.—Prof. Ottolenghi: Malaria.—Dr. N. Bernard: Beri-beri.—Prof. Imbert: Bone-grafting.

April 25 to 28.

German Society for Internal Medicine (at Wiesbaden).—Discussions on Psychotherapy, introduced by Gaupp and Fleischmann; Results of Recent Functional Investigations of the Stomach and Duodenum, introduced by G. Katsch.—A joint meeting with the German Rontgen Society will be held on April 28, with a discussion on the Significance of Rontgen-ray Examination of the Lungs and Mediastinum for Internal Medicine (excluding Tuberculosis), introduced by Distlen, Assmann, Haenisch and Lorey, and Fleischner.

SATURDAY, APRIL 2, 1927.

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Scientific Slaughtering.

THE problem of the humane slaughtering of animals for food is one which has exercised many members of the medical and veterinary professions. It is of direct concern to men of science, first because certain relevant facts which are in dispute can only be settled by rigorously scientific experiment, and secondly, because the ethical principles involved have received a much enhanced significance from the work of Darwin and other zoologists. The discussion recently opened at King's College, London, by Profs. McCunn and Smythe, of the Royal Veterinary College, under the chairmanship of Prof. Julian Huxley, affords an occasion for putting before the readers of NATURE the more important of the facts relating to the slaughterhouse.

In all matters which involve a conflict between ethical principles and economic interests the relevant facts are apt to become entangled in a good deal of special pleading, and in the present case there are certain points upon which even scientific authorities are not in agreement; but although the necessity for further inquiry of a rigorously scientific character is generally recognised, a number of important facts may be regarded as definitely established. The most recent authoritative documents for these are the reports issued by the London County Council on Feb. 15, 1923, and by the Public Health Department of the Corporation of London on April 2, 1925. Considerable importance attaches also to a paper read by Prof. G. H. Wooldridge before a meeting of the National Veterinary Medical Association and published, together with the discussion which followed it, in the *Veterinary Record* of Mar. 4, 1922; and to a report on the Jewish method of slaughtering by Prof. E. H. Starling and Sir Michael Foster, published by the Admiralty in 1904. The views of the meat traders were defended by Prof. Leonard Hill in the *Lancet* of Dec. 22, 1923, but the results of the demonstration arranged by them at Birmingham in November 1923 should be accepted with considerable reserve, so far, at all events, as the question of bleeding is concerned, since (according to Dr. W. J. Howarth, Medical Officer of Health to the Corporation of London) animals were "left on the floor for different intervals before the blood was allowed to be extracted." This incident emphasises the necessity for ensuring that such trials be controlled in every detail (including, by the way, the selection of the animals) by men trained in the rigour of scientific method.

The old-fashioned methods of slaughtering which are employed in the case of about fourteen million animals yearly in Great Britain are broadly as follows: Large animals before being killed are stunned with a poll-axe; pigs are hoisted with a chain attached to one hind leg and stuck, commonly without previous stunning; many calves and some pigs are first stunned with a hammer; occasionally sheep and lambs are similarly stunned, but usually they are lifted on to a 'crutch' or trestle and stuck with a knife while conscious, after which their necks are broken by pressing back the head, the spinal cord being sometimes cut with the knife; Jewish slaughterers, for reasons of ritual, first throw the animal and then cut its throat in every case. The modern method, which is at present used for about one million animals yearly in Great Britain, consists in preliminary stunning with a specially designed pistol, after which the animal must be immediately bled.

From the humane point of view the superiority of the pistol over the poll-axe has been placed beyond serious question by the experiments conducted on behalf of the Corporation of London by the Medical Officer of Health (Dr. W. J. Howarth), the Superintendent of the Metropolitan Cattle Market (Mr. J. R. Hayhurst), and the Veterinary Surgeon at the Central Meat Market (Lieut.-Col. T. Dunlop Young). These officers found, in a number of trials with careful and experienced slaughtermen, that it took on the average 2·49 blows with the poll-axe to stun a bull, 1·23 blows to stun a steer, 1·27 to stun a cow, and 1·55 to stun a large sow or boar. With careless or less experienced slaughtermen the results would have been still less favourable. On the other hand, with a particular captive-bolt pistol, 542 bovines were stunned with 543 shots and 712 swine were stunned with 715 shots. Starling and Foster found that when the throat is cut with exceptional skill (in the Jewish method) the duration of consciousness, as tested by corneal reflex and by purposiveness of movement, varies from 5 to 40 seconds, with an average in the neighbourhood of 20 seconds. The qualitative superiority of the pistol over the knife, from the humane point of view, may be regarded as established, though there is some difference of opinion as to the quantitative aspect of the matter. However, Sir Arthur Mayo-Robson has described an important post-mortem test which does not appear to have been applied in the investigations under consideration: it consists in examining the meninges. Dr. Pfister, Director of the Zurich Abattoir, has found that when animals have been stunned before killing their meninges are normal, whereas in animals killed without stunning, as many millions are in Great Britain, the meninges are intensely congested, a fact which proves that suffering has occurred. Finally, the use of the knife has to be learned by practising upon living animals.

The captive-bolt pistol does not involve danger to the slaughterman or to bystanders, and its use calls for only such reasonable care as may fairly be demanded from a tradesman. The meat traders' federation collected for the London County Council inquiry 15 examples of alleged accidents occurring with 'humane killers' between 1913 and 1920, but of these 5 turned out to be cases of suicide and 4 to be otherwise irrelevant. Of 5 genuine and 1 suspectedly genuine accidents, 5 occurred with pistols of the free-bullet as distinct from the captive-bolt type, and in the remaining case the type of pistol was not specified.

There are, however, other considerations which cannot be quite so easily dismissed. The most difficult of these is the allegation that pigs do not bleed so freely when shot as when killed by the old-fashioned methods, and that shot pigs are therefore less valuable for the manufacture of export bacon. It is also alleged that the flesh of shot pigs is more liable to be disfigured by 'blood splash.' The Corporation of London's research negatives the second of these allegations but leaves the first undecided: not only scientific authorities but also those engaged in the trade are divided on the subject, and further trials are called for. Doubtless a great deal depends on the precautions taken to promote bleeding immediately after shooting. In any case, it should be borne in mind that in large factories the pigs, when hoisted, are attached to a travelling conveyer, and owing to the weight of the animal the pressure of the chain on the leg will cause suffering, apart from the use of the knife.

In the case of sheep the difficulty is somewhat different. If a sheep be lifted on to the crutch and then shot, its struggles are said to make manipulation of the pistol more difficult than that of the knife. If, on the other hand, it be shot on the ground, the labour of lifting it on to the crutch afterwards is increased. Thus a 7-handed gang slaughtering 100 sheep a day might need an extra hand, whose wages would possibly amount to 12*s.* 6*d.* a day. The increased cost of production would therefore be about 1½*d.* per sheep, or 0·025 pence per lb. of mutton. Such a small expense should not be allowed to obstruct the ing of what is clearly just and right; Switzerland, Holland, Germany, Sweden, and Denmark have set an example which Great Britain could follow.

In the Jewish method of slaughter, which is governed by a traditional ritual, the animal is first cast, after which its throat is cut with exceptional skill and elaborate precautions. From the humane point of view throat-cutting is not so satisfactory as stunning, but the most serious objection to this method is the preliminary casting, which in the opinion of Starling and Foster involves definite cruelty, sometimes of a serious character. The Jews are by nature and tradition a humane race, and it should not be impossible for their experts to devise some modification of the procedure which will satisfy all the requirements of the situation. Indeed, so recently as Mar. 17 an important test was held at Brixton of a new apparatus designed by Mr. H. Weinberg to obviate the cruelty involved in casting. It is understood that a number of veterinary surgeons who were present were satisfied that a great advance has been made, and it is to be hoped that mercenary interests will not prevent Mr. Weinberg's apparatus from receiving a more extensive trial.

The compulsory training and licensing of slaughtermen is a pressing requirement, for while most slaughtermen are fully trained before they use the poll-axe, there is no adequate provision for the enforcement of this elementary precaution against the infliction of unnecessary suffering. But perhaps the most serious defect of our slaughtering system, both on humane and on hygienic grounds, is the lack of adequate control and inspection of slaughterhouses. In the more advanced of the Continental countries, private slaughterhouses have been extensively replaced by public abattoirs, but unfortunately in Great Britain private slaughterhouses still exist, and their licences have a capital value which opposes a strong vested interest to the movement for reform. The financial cost of doing what is right in this case is by no means an inconsiderable one. Obviously, however, the element of fear can be much diminished in a properly designed public abattoir, which also facilitates supervision for humane and hygienic ends. Hence public abattoirs alone are tolerable in towns, while in country districts a rigorous system of inspection and control by public officers is called for. The hardship which would be inflicted on the "slink" trade in meat from tuberculous animals could be softened by a good system of insurance.

It will be seen that while a very substantial body of facts may be regarded as established in connexion with humane slaughtering, there are other facts—and particularly as regards the effect on the quality of bacon and the psychological element in the suffering of the animals—which call for authoritative investigation. It is essential that the experimental work involved should be carried out by disinterested scientific men, adequately familiar with the canons of scientific method. However, apart from prejudice and conservatism and the professional pride taken by slaughtermen in a highly skilled trade, which they have learned by long apprenticeship, the opposition to reform is based on mercenary considerations. Even if the shot pig should prove to be somewhat less valuable for export bacon than the pig which has been more painfully killed, the question will arise whether the economic motive should prevail over the ethical.

The Ministry of Health proposes two alternative by-laws for adoption by local authorities, but does not enforce their acceptance. By-law 9a requires that all slaughterers except Jews shall stun the animal before killing it, except in the case of sheep. By-law 9b is similar, but it applies also to sheep and specifies the use of a mechanically operated instrument—that is, in practice, a pistol. Out of some 2000 local authorities only 226 (including t London County Council) have hitherto adopted stricter by-law, though the number is growin response to propaganda by the Royal Society the Prevention of Cruelty to Animals, the Humane Slaughter of Animals Association, and other humanitarian bodies. The adoption of the by-law may put a district at an economic disadvantage in its competition with neighbouring districts for the patronage of butchers, many of whom are prejudiced against the pistol. The Sanitary Committee of the Corporation of London has therefore passed a resolution to the effect that the time is now opportune for the issue of definite regulations which should be of general application throughout Great Britain, and that "in order to secure uniformity such regulations should be issued as compulsory regulations by the Ministry of Health." Presumably the Government will hesitate to take the necessary action until it feels itself supported by a well-informed public opinion, but the subject is an unpleasant one, and the public naturally prefers to know as little of it as possible. In the face of this situation, no apology is needed for having brought it to the attention of scientific men, who are *ex hypothesi* opposed to obscurantism.

C. W. Hume.

Science and Psychic Behaviour.

The British Journal of Psychical Research. Vol. I. No. 5. Jan.-Feb. (London: National Laboratory of Psychical Research, 1927.) 1*s*.

THE accusation is frequently levelled at scientific workers that they will give no thought or credence to the very real phenomena of the supernormal, and that this attitude of aloofness sits ill on those who profess the true scientific spirit. That there is truth in the charge can scarcely be gainsaid. When Sir Oliver Lodge pronounces on a modern development or even a modern speculation of molecular physics, the auditorium is filled with craning necks and assenting minds, but let him turn to the subject of materialisations or the after-life, the scientific necks are relaxed and the minds closed. It is worth while inquiring why this conspiracy of hostile silence is maintained.

It is a truism that trustworthy scientific work can be accomplished only by trained minds after elaborate preparation for a line of attack based on a close study of the problem. For in all circumstances the question at stake is the question of what is and what is not admissible evidence. The scientific process is the method of collecting and assembling that evidence, and no deduction will [illegible]nd that allows of possible ambiguity or for which [illegible] evidence is not both necessary and sufficient. [illegible]n legal standards are not permissible. The [illegible]al conclusion cannot be based on circumstantial evidence, nor does one give an electron the benefit of the doubt. The logic of the law court is not necessarily the logic of the laboratory.

In these circumstances it is permissible to doubt that any individual, no matter how well intentioned, could sail into a notoriously difficult region of inquiry and produce almost immediately astounding results of full evidential value. Even were the individual a trained scientific investigator, there is a natural hesitancy in acceptance, for independent verification by other workers is a necessary and legitimate demand. The difficulty is accentuated when the scientist who undertakes or is present at the inquiry is constrained to work under conditions and limitations the full implications of which cannot be precisely appreciated. The phenomenon, he may be told, will take place only in darkness, or in dull red light, or in the presence of a particular individual or a group of individuals, or when a gramophone plays in the subdued light of a vacuum tube discharge, and so on. If, moreover, the events described as occurring, when accepted, would involve a complete reconsideration of the structure of mechanical processes, reluctance [illegible] admit that the evidence is above criticism is naturally intensified.

These are the difficulties one encounters with most of the material in the publication before us. If the merest fraction of the evidence adduced in this small volume were to be admitted it would cause a revolution in scientific thought. In a lecture delivered at the National Laboratory of Psychical Research, Countess Wassilko-Serecki describes the history—one is almost tempted to write the hysteria—and phenomenon of Eleonore Zügun, a Rumanian peasant girl. In the presence of this girl inanimate objects become endowed with a will of their own, bricks fly about, dishes dash themselves to pieces, a stone jumps out of the river, is replaced and jumps out again, scratches and bites appear on her arm, cups are snatched from her hand by invisible powers, and so on. A great deal of the evidence for this is not direct but produced by the Countess from depositions of individuals abroad. Dr. R. J. Tillyard contributes a record of two séances conducted by a medium in Boston, Mass. Here darkness appears to be essential, and the medium goes into a trance. This is verified at intervals by red light. It would be interesting to have details of the verification of this trance condition conducted in such difficult circumstances, but they are not provided. A gramophone plays a negro melody and a voice—immediately referred to as 'Walter's' voice—talks "freely and wittily" apparently from inside a cabinet. The humour does not, however, appear to be very deep. A flower basket—rendered luminous—moves about high up in the room, rocked by 'Walter,' we are told, but no evidence is adduced about 'Walter' beyond the voice, or as to whether the basket was actually rocked by him.

Much could be said about this kind of science, but restraint is desirable. Numerous questions naturally suggest themselves. If a brick can fling itself through a window, what reliance can be placed on the prediction of the total eclipse in June? What reliance can be placed on the performance of *any* machine? Alternatively, if, as experience shows, full reliance can be placed on a multitude of such predictions, what reliance can be placed on the evidence about the brick? Scepticism becomes charity indeed. There is here a frank conflict of evidence [illegible] until it is resolved the scientist's natural inclin[illegible]s to turn back to the restful haven of verified knowledge. If there are inconsistencies in his own field, if for the moment he cannot reconcile solar mechanics with the mechanics of the electron, his past experience has at least taught him that with patience these troubles will be smoothed. Consistency of behaviour of his material, however, is implicit in his method of approach. Such an assumption may possibly prove to be ill-founded, and the self-propulsion of the brick through the window, referred to above, may ultimately prove to be the actual disturber of his mental peace. But his *malaise* in the presence of such a phenomenon—if true—goes deeper than this. "If the material with which I have to deal," he says, "is not consistent in its behaviour, how can I study the question at all?"

It seems to be inevitable in experiments in this field of inquiry—if they can be called experiments—that a great deal must depend on the good faith of the medium. There is always the lurking suspicion that, consciously or unconsciously, the observers are being deluded—a factor utterly foreign to any class of physical experiment. This suspicion is traceable not so much to the fact that, in the past, trickery has been exposed in the performances of such individuals, as to the fact that results are claimed of a nature antagonistic to the tacit philosophy of the physicist. To meet this difficulty, one of the first tests that ought to be performed should be to determine the precise conditions under which a medium can be dispensed with. Quite obviously, the smaller the number of persons actually essential to an experiment, the greater the confidence in the result. Is it not possible for the National Laboratory of Psychical Research to produce the details of a single and convincing experiment that could be performed by any competent scientific worker in his own laboratory, as simple, say, as measuring the period of a pendulum? If 'levitations' are as frequent as they are claimed, this should not be impossible. The writer has frequently tried such experiments alone, but always in vain. What are the conditions that will ensure success? Surely, after so many years' experimentation by devotees of the cult, including many eminent men, this must be known very accurately. All the tests described in the publication under review are so complex that instead of carrying conviction they arouse suspicion. It is the simple test that is required.

There is, however, another—and possibly more important—factor that repels the scientist: it is the implications and assumptions inherent in the descriptions of these uncanny doings. If a voice is heard speaking from a box, is it necessary to assume it has an owner, 'Walter'? In a court of law it might be a legitimate assumption to make, and it might in conceivable circumstances be sufficient to hang a man, but in the description of a scientific experiment, why imply the existence of an 'owner' to the voice and by identifying it with 'Walter'? Even assuming the accuracy of the phenomenon, which in the circumstances one would be far from doing, there are numerous possible working hypotheses of a more normal type than that of 'spirits.' When Sir Richard Paget makes his hands speak, one does not assume that the voice belongs to a spirit, even if it does call itself 'Walter.' Men of science have learnt that words are treacherous things, that false ideas of an ignorant past are dragged in at each turn, so they have learned to talk in symbols, with a clear-cut (1, 1) correspondence between idea and symbol. But the language of supernormal behaviour—and the very phrase itself is dangerous—is not yet sufficiently divorced from mystery and superstition, not yet sufficiently definite and precise, to ensure that the pet theories and vague beliefs of its devotees are not foisted on the unwary inquirer as he receives his description of the phenomena.

If the National Laboratory of Psychical Research can produce a simple laboratory experiment, capable of being performed by a careful and trained scientist under conditions that he himself can guarantee and control, it would go further towards producing the revolution in thought which the Council so earnestly desires than volumes of 'evidence' of the type given in the present issue of its Journal.

H. Levy.

Dynamics and Ballistics.

(1) *Lezioni di meccanica razionale.* Per Tullio Levi-Civitá e Ugo Amaldi. Volume secondo: *Dinamica dei sistemi con un numero finito di gradi di libertà.* Parte prima. Pp. x+527. (Bologna: Nicola Zanichelli, 1926.) 65 lire.

(2) *New Methods in Exterior Ballistics.* By Prof. Forest Ray Moulton. Pp. vi+258. (Chicago: University of Chicago Press; London: Cambridge University Press, 1926.) 20*s.* net.

(1) THE monumental treatise which Profs. Levi-Cività and Amaldi are engaged in writing on rational mechanics (to use the comprehensive title established on the Continent) is divided into three volumes, which deal respectively with kinematics and statics, dynamics of systems possessing a finite number of degrees of freedom, and dynamics of continuous systems. The second volume is divided into two parts, to the second of

which are reserved the general questions properly belonging to rigid dynamics and the subjects of canonical equations of motion and the principle of Hamilton and Jacobi.

The plan of the first part of the second volume is as follows: The first two chapters discuss the motion of a particle constrained to move on a given curve and on a given surface. The third chapter deals with problems of gravitational attraction. General theorems on momentum, energy, and work are treated in Chapter iv. D'Alembert's principle and Lagrange's equations occupy Chapter v., and the volume closes with a chapter on stability of motion and small oscillations.

Chapter iii., which is mainly concerned with celestial mechanics, contains interesting applications to planetary orbits according to Einstein's law of gravitation and to electronic orbits according to Bohr's atomic theory. The motion of electrons in an electromagnetic field also furnishes interesting examples. It is, indeed, a refreshing change to discover so little space devoted to questions better fitted to exercise a student in integration than in dynamical principles.

Into the time-worn problems to which so large a proportion of any work on dynamics must be consecrated it would be difficult to introduce much originality of treatment. Yet throughout this work, Profs. Levi-Civita and Amaldi have succeeded in revivifying these 'dry bones' by a continual slight novelty, most stimulating to the reader. The work is planned on generous and comprehensive lines and covers ground scarcely touched in any similar treatise. It even contains a fair number of exercises for the student.

(2) Prof. Moulton's short account of some methods of external ballistics discusses the three main problems of the effects of air resistance, rotation of the projectile, and minor factors such as winds, on the projectory. The effect of air resistance is studied by the methods of finite differences, extensively used by Bashforth in England during the last century. The effect of abnormal air densities, variations in gravity, winds, etc., is studied by the method of perturbations, so widely used in astronomy. The effect of rotation is discussed by means of the classical equations of Euler. The book contains no reference to the pioneer work of Bashforth or to the work of Siacci. Few of the methods given appear to be new, and a remarkable new method due to Whitehead ("Graphical Solution from High-Angle Fire," *Proc. Roy. Soc.*, 1918) is not mentioned. It seems that the title of the book is scarcely an accurate description of its contents. Considerable interest therefore attaches to an ingenuous admission in the introduction. "In view of the complete independence of the present developments from those that have gone before, no attempt has been made to treat the question historically, nor even to connect these results with those of earlier writers." This is an explanation, if not an excuse.

Animal Nutrition in Sweden and Denmark.

Fütterung der Haustiere: ihre theoretischen Grundlagen und ihre wirtschaftliche Durchführung. Von Prof. Nils Hansson. Übersetzt von Franz von Meissner; überarbeitet und mit einem Vorwort versehen von Prof. Dr. Georg Wiegner. Pp. xii + 230. (Dresden und Leipzig: Theodor Steinkopff, 1926.) 8 gold marks.

THE science of animal nutrition is concerned with the principles underlying the economical transformation of the produce of the soil into articles of human diet like meat and milk. The elucidation of these principles depends on a knowledge of two sets of factors: first, the nutritive requirements of the different classes of farm stock for the purposes of maintenance and of production (*e.g.* growth, fattening, and milk production); and secondly, the capacity of the various feeding stuffs for supplying these requirements.

It is instructive to note how these problems have been attacked in Germany and the United States on one hand, and in the Scandinavian countries on the other. In Germany the well-known investigations conducted by Kellner on fattening oxen in the respiration calorimeter have led to the formulation of a system of starch values, in which the productive or, more strictly speaking, the fattening value of a feeding stuff is defined in terms of pounds of starch. Kellner's system has been widely adopted in Britain, where, within limits, it has given useful results, though criticism of the method at the present time is not lacking. Armsby in the United States, also working with fattening oxen in a respiration calorimeter, has evolved a system of net energy values in which the productive value of a feeding stuff is stated in terms of therms of energy.

In northern Europe, however, where dairy cows, and not fattening oxen, have been mainly employed in feeding investigations, it has been the custom to take milk production as a measure of the productive value of a feeding stuff. Experiments on these lines were first started by Fjord at Copenhagen so long ago as 1885, and since 1898 these have been continued and expanded in a series of fundamental researches carried out by Nils Hansson at Stockholm. From the results of these feeding trials came the conception and development of the Scandinavian food unit system, which is now accepted as the basis of feeding in Sweden, Denmark, Norway, Finland, Poland, and other countries. This system, based on Hansson's data, has undoubtedly, in its application to feeding practice, achieved a larger measure of success in northern Europe than has any other system in any other country, and to its adoption must be attributed in no small degree the vast growth of the butter export trade of Denmark and the enormous increase in milk production in Sweden and other northern lands.

Prof. Hansson's main work, "Handbok i Utfodringslära," was published in three parts and contained a detailed account of the development and application of the food unit system. The present volume appeared in 1922 under the title of "Husdjurens Utfodring" and brought together all the essential features of the "Handbook" in carefully condensed form. Unfortunately, not many English workers are able to read Swedish with any degree of ease, and this fact probably explains the somewhat tardy recognition of Hansson's ideas in Britain. The translation of "Husdjurens Utfodring" into German is the direct outcome of a widespread desire among German nutritional scientific workers to know more about a feeding system which has proved so successful in other countries.

The treatment of the subject is characterised by the simplicity and logical clearness for which Hansson's publications are justly celebrated. The first section opens with an account of the composition and digestibility of feeding stuffs, the concluding chapter of this section dealing with the different methods of assessing productive values. The English reader will be particularly interested in the comparative account of the Hansson food unit, the Kellner starch value, and the Armsby net energy value. In the second section the nutritive properties of the individual feeding stuffs are dealt with, while the third and concluding section is devoted to a thorough consideration of the scientific principles underlying the nutrition of calves and other young animals, of dairy cows and fattening oxen, of sheep, pigs, goats, and horses. The tables at the end of the book constitute a praiseworthy feature. Table I. gives the average composition and digestibility of a very large number of feeding stuffs, together with their productive values in terms of food units, starch values, and milk-producing values. In Table II. the nutritive requirements of all classes of farm stock are recorded in great detail.

It is to be hoped that the translation of Hansson's treatise into English will not long be delayed. Affording as it does a fresh and hopeful outlook on the problems of the economical feeding of farm animals, especially of dairy cattle, it should prove a worthy companion volume to the well-known treatises of Kellner and Armsby and the more recently published text-book of the Cambridge worker, Prof. T. B. Wood. It should be read with interest and profit not only by the investigator in this domain of science, but also by all stock-breeders who are desirous of rearing their animals in accordance with accepted scientific principles.

H. E. WOODMAN.

Our Bookshelf.

Delusion and Belief. By Prof. Charles Macfie Campbell. Pp. v+79. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1926.) 6*s.* 6*d.* net.

THIS is an interesting study of the relation of the various beliefs which men have held at different times to their conduct of life. The method of treatment begins with the biological study of belief, pointing out how, although we cannot tamper experimentally with our fellows in regard to the main issues of human life, yet Nature does not shrink from exposing men to the most searching tests.

Various beliefs are discussed which are concerned with topics of high emotional value, such as bereavement, unsatisfied love, and ungratified ambition, and it is pointed out and examples are given of the way in which the attitudes and beliefs of the individual have a strongly subjective note. In the latter part of the book, man's general belief concerning the mechanism of Nature and the order of the cosmos is discussed. Here again the personal viewpoint is noted. The question of the mental health of the individual and the group depends largely on the underlying scheme of values.

The book concludes with a discussion of what the author terms inferior beliefs about health, such as Christian science. Although admitting the personal comfort in some cases, he maintains that any increased efficiency is largely due to adopting the healthy attitude that, even when there is some physical ailment, it is often better to ignore it and to go on playing the game of life. He also points to the danger of inferior beliefs about social problems, such as that of the optimist who talks of universal peace and often denies the existence of harsh realities and hatreds. The belief in the spiritual order of the universe is an important driving force, but it must also be associated with the workaday world. Although tolerant of various beliefs, Prof. Campbell's conclusion is that instead of discovering something absolute in the realm of belief, one finds that beliefs are the tools of life rather than rare intellectual products to be cherished carefully for themselves. H. D. A.

Tribal Dancing and Social Development. By W. D. Hambly. Pp. 296 + 26 plates. (London: H. F. and G. Witherby, 1926.) 21*s.* net.

Mr. Hambly has surveyed dancing and music as a communal activity and expression of emotion literally from the cradle to the grave, for he begins with the celebration of a birth and ends with the dance which follows death—often long after death, like the dance in the Nicobarese ceremony of disinterring the dead and collecting their bones. He does not concern himself with the individual or merely exhibition dancing as such, although in some of the Eastern dances it would be difficult to draw the line—for example, the whipping dance as a test of endurance as performed in the Sudan which he describes—and it would be easier to discriminate even in this case if it were possible to trace whether or not there were any possible connexion with the whipping ceremony sacred to Artemis, which was once celebrated at Sparta.

Important as it may be to consider dancing as a tribal or group activity, as an expression of an emotion, in ultimate analysis, it must be individual; and the same applies to music. In both cases, fundamentally, the appeal is to the rhythmic sense. Even in music, melody appears to be secondary. Those who have heard real savage music know what a wild appeal to the emotions can be made by the mere rhythmic beating of a drum; while the effect of modern dance music, undeniably, however much it may be disliked, lies in its beat and not in its tune. An analysis of the dance, whether individual or communal, as an effect of rhythmic appeal, has yet to be written.

Mr. Hambly's treatment is on more objective lines. His survey of the facts is a useful study of the geographical distribution and character of the dance as an element in ceremonial, which will be invaluable to the student and at the same time serve to bring home to those whose interest is least specialised, its importance as a social factor which, if not approached sympathetically in administration, might give rise to infinite difficulty.

The British Journal Photographic Almanac and Photographer's Daily Companion, with which is incorporated The Year Book of Photography and Amateurs' Guide and The Photographic Annual, 1927. Edited by George E. Brown. Pp. 820 + 31 plates. (London: Henry Greenwood and Co., Ltd., 1927.) Paper, 2*s.* net; cloth, 3*s.* net.

This is no longer an almanac, except in name, for that particular feature of the annual has been omitted since a year or two ago, presumably because it was not appreciated. We appreciated it and often turned to it After four articles dealing with the use of reflex cameras, arranging snapshots, developing and printing amateurs' films, and the use of 'chlorobrom' papers, follows the valuable "Epitome of Progress," which is a concise and classified history of photography for last year. It includes a very brief summing up of the most striking advances, the events of the year, besides trade and legal items. The largest section of the epitome concerns apparatus, equipment, and processes, and consists of abstracts of the accounts of these that appeared during the year, with all necessary formulæ and many illustrations. After the obituary, 65 pages of formulæ and instructions for the current photographic operations, and 40 pages of tables, comes a section of miscellaneous information. This last includes an excellent "History in Brief" of photographic and photomechanical processes, and various directories. With the text are 30 photogravure reproductions of photographs by some of the most noted workers. The annual fully maintains the unique position that it has earned for itself during its sixty-seven years of issue.

Three Lectures on Atomic Physics. By Prof. Arnold Sommerfeld. Translated by Dr. Henry L. Brose. Pp. iv + 70. (London: Methuen and Co., Ltd., 1926.) 2*s.* 6*d.* net.

It is encouraging to find that these important lectures by one of the most prominent authorities on spectroscopy, delivered under the auspices of the University of London, are now accessible to all in English. They deal with the spectra of hydrogen and helium, and then proceed to the study of complex spectra such as manganese, iron, nickel, and palladium in the light of Pauli's "Principle of Uniqueness." The third lecture gives some much-needed information concerning the structure of crystals, from the point of view of the quantum theory.

The translation is carefully done, but errs on the side of literalness. The translation of *Grundzustand* as 'ground state' is scarcely English, while *abgeschlossen* as applied to systems of elements is 'self-contained' rather than 'completed,' and 'quantize' is rather more exotic than 'quantify' would be.

New Conceptions in Colloidal Chemistry. By Prof. Herbert Freundlich. Pp. vii + 147. (London: Methuen and Co., Ltd., 1926.) 6*s.* net.

This volume contains eight lectures delivered by the author in America in 1925. They deal in a masterly manner with the progress made along certain lines in colloid chemistry during the last few years, and indicate that such matters as adsorption, electrolyte coagulation, and the electrical and optical properties of colloidal systems are not so simple as they were once thought to be. The ample bibliographies, although impartial, show how fundamental is the work of Prof. Freundlich himself, who is to be congratulated on the rare gift of making his discoveries intelligible in two languages, for a German version of the book has already appeared. P. C. L. T.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Constitution of Mercury Derived from Coal Tar.

IT will doubtless be a surprise to many readers of NATURE, as it was to me, to hear that the element mercury is obtained in the distillation of coal tar. This fact was recently brought to my notice by Mr. W. Kirby, of the South Metropolitan Gas Co., who kindly provided me with a sample for examination of its isotopic constitution. He informs me that the mercury appears in the lightest of the fractions distilled and occurs to the extent of about one part in seven millions of undistilled tar. Its accumulation in any reasonable quantity will, therefore, take place only in a plant arranged for continuous fractionation.

It was my first intention to compare its density with that of ordinary mercury, and if any appreciable difference was detected to submit it to analysis by the mass-spectrograph, but a favourable opportunity having occurred, I have been able to perform the latter operation under advantageous conditions. The discharge bulb was washed with carbon dioxide until all trace of the spectrum of mercury had disappeared. A portion of the sample was then introduced. This operation was more troublesome than I expected; but ultimately the bulb was flooded with the vapour and a number of mass-spectra were obtained, while the mercury spectrum was predominant in the discharge. On these the groups of isotopic lines were absolutely indistinguishable, both in position and intensity relations, from those of ordinary mercury described in NATURE, Aug. 8, 1925.

F. W. ASTON.

Cavendish Laboratory,
Cambridge, Mar. 10.

The Passage of α-Rays and β-Rays through Matter.

THE loss of energy suffered by a fast-moving electrified particle passing through matter, and the ionisation produced by the moving particle, are phenomena which have, so far, not received accurate quantitative explanation. There are two main theories of the stopping-power due respectively to Bohr (*Phil. Mag.*, 25, 10; 1913; and 30, 581; 1915) and Henderson (*Phil. Mag.*, 44, 680; 1922). The theory of the primary ionisation due to a fast-moving particle is as it was left by Thomson in 1912 (*Phil. Mag.*, 23, 449). In all these theories, classical mechanics is used to calculate the possible energy transfers during encounters between the moving particle and the atomic electrons, and Fowler (*Camb. Phil. Soc.*, 21, 521; 1923) has suggested that the discrepancy which exists between theory and experiment may be due to the inaccuracy of classical mechanics in this field. *Whether this is so or not, it may be of interest that a fair proportion of the discrepancy between classical calculations and experimental results disappears when the motion of the atomic electrons is allowed for.* The effect of this motion may be considerable, though the velocity of the electron be small compared with that of the moving electrified particle.

The momentum imparted to an electron by a fast-moving electrified particle is to a first approximation independent of the initial motion of the electron, and it is the same as that communicated to an initially stationary electron provided the shortest distance between the undisturbed paths of the electron and moving particle is the same in both cases. If ϵ represent the kinetic energy of the electron in its orbit and Q_0 the energy given to an initially stationary electron, then, adding momenta, we find that the energy, Q, acquired by an electron is given by

$$Q = Q_0 + 2\sqrt{Q_0 \epsilon} \cos \phi, \quad . \quad . \quad . \quad (1)$$

where ϕ is a random angle. It would appear that as the value of Q averaged for *all* ϕ is Q_0, it is unnecessary to take the second term on the right-hand side into account. However, in Henderson's theory of the stopping-power and Thomson's theory of ionisation, it is not legitimate to average for all ϕ, only those values of ϕ for which Q is greater than a certain minimum value being concerned. (In Bohr's theory there is no such minimum and it is legitimate to neglect the motion of the atomic electrons.) It follows from (1) and the classical expression for Q_0 that in an element dx of its path the average number, dA, of encounters in which the moving particle gives to the electron energy between Q and $Q + dQ$ is given by

$$dA = \frac{2\pi N' E^2 e^2}{mv^2} \frac{dQ}{Q^2}\left(1 + \frac{4}{3}\frac{\epsilon}{Q}\right)dx, \quad . \quad . \quad (2)$$

usual notation being used. This expression is greater by the factor $1 + \frac{4}{3}\frac{\epsilon}{Q}$ than the expression for stationary electrons. By integration we find that the primary ionisation is given by

$$I = I_P = \frac{2\pi N E^2 e^2}{mv^2} \sum_{s=1}^{n} \frac{1}{V_s}\left(1 + \frac{2}{3}\frac{\bar{\epsilon}_s}{V_s}\right) = k \sum_{1}^{n} \frac{1 + \frac{2}{3}\frac{\bar{\epsilon}_s}{V_s}}{V_s}, \quad (3)$$

N being the number of molecules per unit volume, n the number of electrons per molecule, V_s the binding energy of the sth electron, and $\bar{\epsilon}_s$ its average kinetic energy. (Quantities of the order of u^2/v^2 where u is the initial velocity of the electron and v the velocity of the moving particle are neglected, and this represents the accuracy of the results.) According to Thomson's theory

$$I = I_T = k \sum_{1}^{n} \frac{1}{V_s}. \quad . \quad . \quad . \quad (4)$$

The difference lies in the extra term $\frac{2}{3}\frac{\epsilon}{V}$ in the numerator of (3). ϵ/V is generally equal to or greater than unity, so that the new value is at least about 70 per cent. greater than the old value. C. T. R. Wilson (*Proc. Roy. Soc.*, 104, 192; 1923) found that the primary ionisation produced by β-rays in air was about double Thomson's theoretical value. The value given by (3) is thus nearer the experimental value than the value given by (4), although the uncertainty of atomic data prevents a final comparison. The data for hydrogen is more certain, and certain experimental results obtained by the writer for this case are in satisfactory agreement with the new result. The new theoretical value in fact agrees to within about 5 per cent. with the observed value of the primary ionisation in hydrogen, whilst the theoretical value according to Thomson's theory represents little more than half the observed ionisation.

If R represents the first resonance potential of an electron, then Fowler (*loc. cit.*) has shown that the stopping-power according to Henderson's theory is approximately given by

$$S_H = \frac{2\pi N E^2 e^2}{mv^2} \sum_{s=1}^{n} \log Q_m/R_s \quad . \quad . \quad (5)$$

Q_m being the energy given to a stationary electron in an end-on collision. According to the present calculations, in which the motion of the electron is allowed for, the stopping-power is given by

$$S_P = \frac{2\pi N E^2 e^2}{mv^2} \sum_{s=1}^{n} \{\log Q_m/R_s + 4\bar{\epsilon}_s/3R_s\}, \qquad (6)$$

the correction being equivalent to decreasing R by a factor of $e^{4\bar{\epsilon}/3R}$. Fowler has shown for α-rays and Wilson for β-rays that the expression (5) is appreciably less than the observed stopping-powers. The curves in the accompanying figure show to what extent the corrected formula agrees with observations in the case of oxygen.

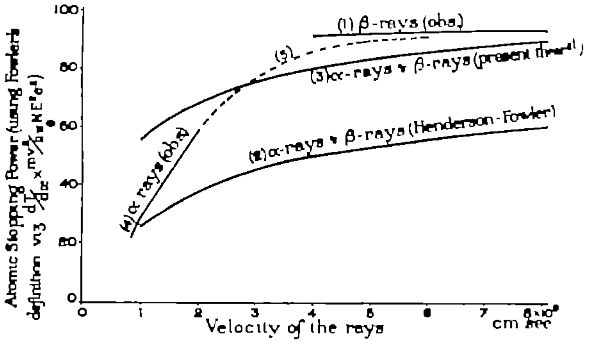

Fig. 1.

Curve (1) represents observed values of the atomic stopping-power for β-rays in oxygen, obtained recently by J. M. Nuttall and the writer (*Phil. Mag.*, **2**, 1109; 1926): curve (2) stopping-powers calculated by the Henderson-Fowler formula: curve (3) stopping-powers calculated by the formula proposed here. In curve (4) the observed stopping-powers for α-rays are plotted. To avoid having too many curves the value of Q_m for β-rays is taken equal to the value for α-rays having the same velocity, and a corresponding reduction of the observed values for β-rays is made (involving a change of about 15 per cent.). After making this reduction the theoretical curves for α-rays and for β-rays coincide.

Although the data used in calculating S_P and S_F is rather uncertain, there can be no doubt that the corrected formula (5) shows a better agreement with observation than formula (4).

It is to be expected that the theoretical formulæ for stopping-power should fail at small velocities because it has been assumed that the 'times of collision' for all 'effective' collisions are small compared with the period of revolution of the electron in its orbit. If this condition is not satisfied, there is an *extra restriction* imposed upon the transfer of energy to the atomic electrons, and the stopping-power represented by curve (3) is consequently too high at the lower velocities. This effect probably accounts for the fact that the observed α-ray curve is below curve (3), and also for the comparatively rapid variation of the stopping-power for α-rays with velocity. The relative effect of this new restriction would be expected to be somewhat greater for α-rays than for β-rays with the same velocity. On this view the observed α-ray curve at higher velocities should approach asymptotically the observed β-ray curve, as is indicated by the broken curve (5). It would be interesting to know the stopping-power for α-rays faster than those from radium-*C* to see if this is the case.

E. J. Williams.

The University,
Manchester, Feb. 24.

Coup-de-Poing.

Of that famous palæolithic implement which the French call a 'coup-de-poing,' the function is still unknown and disputed; it was once called a 'celt,' and is still regarded by some experts as the head of a once hafted ax; others, like the late M. Commont, have argued that it was used as a scraper, and still others maintain that it is an ax without a helve.

In order not to do violence to the feelings of some of our friends by forcing upon them a name which expresses a view from which they differ, I have suggested, as non-committal and non-combative, the use of a proper name; thus following the example of physicists, who speak of a watt or a volt.

The name I proposed is that of the famous Frenchman, who did such splendid service with the 'coup-de-poing' in his fight over the antiquity of man. I allude, of course, to Jacques Boucher de Crèvecœur de Perthes. From this full title I chose his family name of Boucher. This is not a Christian name, as my friend Mr. Balfour supposes, and my authority for saying this is our distinguished colleague, the Foch professor of French.

A second objection raised by Mr. Balfour in his interesting review (Nature, Feb. 12, p. 226), is that Mr. Neville Jones has misapplied the name. I do not think he has, but this is nothing to the point, for he distinctly asserts that he uses the word 'boucher' as equivalent to the French 'coup-de-poing.'

Admiring as I do the consistent courtesy of Mr. Balfour, which is not confined to his friends, I feel sure he will not wish to introduce into our nomenclature a term like 'hand-ax,' which is eminently controversial and has not even the advantage of elegance. Who would speak of a knife-blade without a handle as a 'hand-knife'?

W. J. Sollas.

University College, Oxford,
Feb. 23.

I am glad that Prof. Sollas has commented upon a remark of mine in my review of Mr. Neville Jones's book, as it gives me an opportunity of correcting an error of my own. When I referred to Prof. Sollas's "Ancient Hunters," in order to ascertain his original application of the term *boucher*, I read the passage (p. 112) as indicating that he wished to apply it to implements "made by striking off with a single blow a thick flake from a larger block of stone, and dressing the side opposite the surface of fracture by several blows directed more or less parallel to its length." I have again read the passage and realise that his intention was to suggest *boucher* as equivalent to the French *coup-de-poing*. I was misled through not having read the passage on the succeeding page, and I assumed that "it" in the sentence "In English it has no name," referred to the type described as above quoted. My reading of the paragraph was also partly influenced by the author having drawn a decided parallel between the Tasmanian implement-type, to which he had just referred, and the so-called *coup-de-poing* series. I apologise for having misinterpreted his intention.

At the same time, I cannot admit that the Tasmanian type—a typical *flake*-implement—is to be regarded as the "homologue, or rather analogue," of the *coup-de-poing*—an equally typical *core*-implement. The technique employed in making the two types is essentially different, and the resultant edges differ in character and, doubtless, in application. But, even if *boucher* is offered as a term to take the place of *coup-de-poing*, I cavil at its adoption, since it is made to cover such a variety of distinct implement-types, ranging from the Chellean pick-like tools with rounded butts and pointed 'business' ends, to the specialised ovates of the Upper Acheulian series. It is used, in fact, to denote very dissimilar types of tools, the form and presumable function of which have but little in common. It is true that I feel equally dissatisfied with those widely-adopted terms *coup-de-poing*, *faustkeil* and *hand-axe*, all of which, as commonly used, beg a very debateable question; as I venture to doubt whether those early-palæolithic tools which were equipped with a sharp edge all round their contour, were habitually used unhafted (*vide* Sollas, p. 74). I mention this in order to emphasise how badly we are in need of a revised and reasonably descriptive terminology in prehistoric archæology. My chief reason for protesting against the adoption of the term *boucher* is its vagueness. It is used to embrace such a wide range of distinctive types that it really ceases to have a descriptive value, and is liable to cause confusion.

As to the name itself, I have been fully aware of the complete name of Jacques Boucher de Crèvecœur de Perthes, and that, strictly speaking, Boucher is not the Christian name; but the abbreviated name-formula, Boucher de Perthes, under which he is universally, and by most people exclusively, known, suggests 'Boucher' as, shall we call it, a *prénom*, and a correlation, albeit erroneous, with such names as John of Gaunt, William of Wykeham, etc., and this opens up a vista of *prénoms* adopted as generic or specific names for types of prehistoric implements. I am far from wishing to discourage homage to that great pioneer, Boucher de Perthes, but I do feel that our great debt to him could be paid more effectively than by requisitioning his name (or, rather, one of his names) for the purpose advocated; since the suggested term *boucher*, by embracing so much, signifies so little.

I greatly regret to find myself even in trivial disagreement with my good friend, Prof. Sollas, and I am merely desirous of expressing an opinion, which, if challenged and debated, may possibly be productive of good, as helping to stimulate the introduction of an adequate terminology in prehistoric archæology.

In regard to the last paragraph in Prof. Sollas's letter, I may say, though I risk his thinking me wholly unregenerate, that I feel no aversion from the use of the term 'hand-axe,' so long as it is confined to blades of axe-like form, the shape of which suggests that they were used unhafted. Nor do I see any objection to applying the term 'hand-knife' to a knife-blade which was not fitted with a handle. Such terms, where appropriately applied, have at least the utilitarian merit of being fairly descriptive, even though they may lack elegance. There is, moreover, precedent in the familiar expressions, 'hand-line,' 'hand-spike,' etc.

HENRY BALFOUR.

Carbon Monoxide Poisoning in the Absence of Hæmoglobin.

MR. J. B. S. HALDANE's interesting letter on the above (NATURE, Mar. 5) reminds me that in 1886 I made experiments on the influence of carbon monoxide, as well as of other gases (carbon dioxide, hydrogen, nitric oxide, nitrous oxide, sulphur dioxide, and hydrogen sulphide), on the vitality of three specific micro-organisms, namely, *Bacillus pyocyaneus*, Finkler's spirillum, and Koch's spirillum of Asiatic cholera. The results were published in the *Proceedings of the Royal Society* (vol. 45, pp. 292-301), but a brief reference to them may not be out of place now, inasmuch as they bear on this matter of the toxicity of gases.

The method of experiment consisted in exposing the several organisms, in the form of gelatin-peptone plate-cultures, to an atmosphere of the particular gas, a corresponding control-plate of the same culture being simultaneously incubated in atmospheric air. The behaviour of the three microbes in question in respect of carbon monoxide may be gathered from the following experimental results:

BACILLUS PYOCYANEUS.

	Air-plates (after 4 days' incubation).	CO-plates (after 7 days' incubation)
Number of colonies developing from 1 c.c. of culture . .	113,978	0

When the above carbon monoxide plates were further incubated in air, 100,821 colonies made their appearance. Thus the carbon monoxide had had practically no *permanent* toxic effect on the bacilli distributed in the culture, which had been exposed for a period of 7 days to the gas.

KOCH'S SPIRILLUM CHOLERÆ ASIATICÆ.

	Air-plates (after 4 days' incubation)	CO-plates (after 7 days' incubation).
Number of colonies developing from 1 c.c of culture .	52,020	19,494

On subsequent further incubation of the carbon monoxide plates in air during 4 days, no increase in the number of colonies took place.

FINKLER'S SPIRILLUM.

	Air-plates (after 3 days' incubation)	CO-plates (after 7 days' incubation)
Number of colonies developing from 1 c c. of culture . .	4574	2

On further incubation of the carbon monoxide plates in air during 4 days, the number of colonies rose to 501.

Thus in both cases, and especially in that of the Finkler spirilla, a large proportion of the individuals had been killed or rendered incapable of multiplication into colonies by exposure to the gas.

It may be of interest to add that plates incubated in atmospheres of nitric oxide, sulphuretted hydrogen, and sulphur dioxide respectively developed no colonies, nor were any developed afterwards on placing the plates in air-chambers. These three micro-organisms are therefore rapidly and permanently poisoned by the gases in question.

Interest, again, attaches to the behaviour of the organisms exposed to nitrous oxide (N_2O). The *B. pyocyaneus* developed no colonies in this gas, but afterwards in air almost as many colonies made their appearance as on the control air-plates. Koch's spirilla, in nitrous oxide, developed nearly one-third of the number of colonies present on the air control-plates, a further but only slight increase taking place on their transference to air. In the case of Finkler's spirilla, in nitrous oxide, the number of colonies was about one-seventh of that on the air-plates, whilst the further colonies which appeared after transference to air brought the total to about one-fifth of the number on the air-control. The effect of nitrous oxide on these three micro-organisms is thus very similar in character to that exerted by carbon monoxide.

An atmosphere of carbon dioxide, again, prevented the development of any colonies on the plate-cultures of all three organisms, and only in the case of *B. pyocyaneus* did any appear on transference to air, and then only to the extent of about one-twelfth of the number present on the control air-plates.

In reviewing the record of these experiments made forty-one years ago, it is obvious how greatly the investigation could be extended in various directions. Thus, for example, it would be particularly interesting to ascertain the deportment of sub-cultures made from the colonies appearing on plates which had been exposed to the toxic gases. By pursuing such experiments through a succession of generations it might be possible to arrive at 'strains' of the organisms endowed with the capacity to resist the inhibiting action of a particular gas. Again, differences in behaviour towards a given toxic gas might be made a means of discriminating between otherwise similar organisms, and thus adding yet one more to the already overwhelming number of tests employed in bacteriological diagnosis.

PERCY F. FRANKLAND.

Loch Awe, Argyll.

The First Public Chemical Laboratory in England.

THE statement (NATURE, Feb. 19, p. 300) that the chemical laboratory opened in 1828 in University College, London, is the oldest public chemical laboratory in Britain can scarcely be accepted without qualification, in view of the fact that the University of Oxford had built a laboratory fitted for chemical studies so early as 1683, and that this remained in use until superseded in 1848 by Dr. Daubeny's new laboratory at Magdalen College.

The use that was made of it was intermittent, and the modern practice of class teaching necessitating the multiplication of sets of apparatus had not been evolved; but still the possibility for a person to witness an experiment, even if he did not wish to make it himself, was there.

In those early days the University of Oxford appears to have done little for chemical studies beyond the initial provision of the laboratory and of "the Alkanor and Great Reverberatory" furnaces, and larger utensils such as the great alembic, barrel and worm, with which it was equipped. Smaller earthen and glass vessels and chemicals appear to have been the private property of the laboratory assistant for the time being, who was permitted to increase a very meagre salary by selling to experimenters chemical preparations "at easie rates" and by taking payment for the performance of experiments himself.

Notwithstanding the non-existence of any special university teachers of chemistry, useful practical instruction had been given in connexion with courses of public lectures in the laboratory at various times during the eighteenth century. The auditors were largely composed of medical students, with a sprinkling of the more intelligent members of the general public, who, like Princess Anne in 1683, entered the laboratory to see experiments "to their great satisfaction"; and some of the more curious-minded of these would doubtless have sought to try the experiments themselves. Dr. John Freind, described as well skilled in practical chemistry, in 1704 began courses of *Prælectiones Chymicæ* in the laboratory, which were partly based on experimental work there, and were printed and reprinted for the next twenty years. Richard Frewin was among those who acted as assistant, and it is not unlikely that there too Dr. John Wall, the inventor of Worcester china, may have learnt his chemical manipulation. George Wingfield has left a written record of the methods of analysis in vogue in 1759, and in 1781 a considerable class of divines is reported to have waded "considerably deep in chemistry." Contemporary notes taken four years later by a pupil of Dr. Martin Wall show the distinctly practical trend of the instruction given, and from 1788 until 1793 the celebrated Dr. Beddoes, later patron to young Humphry Davy, drew to the Ashmolean "the largest classes known in the University since the thirteenth century." It was the period when the work of Sadler, the aeronaut, also helped to popularise chemical experiments in Oxford.

Between 1803 and 1822 the existence of the laboratory made it possible for the first Aldrichian professor of chemistry, Dr. Kidd, to deliver courses of from twenty-six to thirty lectures on the subject of his chair during the winter terms, but owing to the lateness of the hour, 7 P.M., it was unlikely that much work was done in the laboratory by his students. One, at any rate, the poet Shelley, is known to have continued experiments in his untidy rooms in college, while the professor himself worked in the University laboratory at his own researches. Doubtless the dim light of the few candles, or oil lamps, which would have been the only source of illumination then available, as well as the grime of ages on the vaulted ceiling of the laboratory, enhanced that appearance of gloom which has been so often remembered by our visitors during the early years of the nineteenth century, and which was unsuited for the critical operations of analytical chemistry as then practised. But it was not before 1848 that the old laboratory was superseded in Oxford, and the fact remains that for over a hundred and fifty years the Ashmolean had provided England with its first public university laboratory, "the designe of this building being not onlie to advance the studies of true and real philosophy, but also to conduce to the uses of life and the improvement of medicine."

R. T. GUNTHER.

The Old Ashmolean,
Oxford.

The Spinning Electron in Wave Mechanics.

THE new wave mechanics admits the existence in physical phenomena of a variable quantity that satisfies a special differential equation. According to Schrodinger, this function ψ is such that the product $\psi\bar{\psi}$, where $\bar{\psi}$ is the conjugate complex quantity, is the electrical density. On the contrary Bateman (NATURE, 118, 839) has recently shown that, by considering two functions, each of which satisfies the wave equation, it is possible to determine the potentials **a** and ϕ of the electromagnetic field. Starting from Bateman's considerations, de Broglie (*C.R.* 184, 81) has shown that the values calculated with this theory coincide with those of Maxwell's theory if one admits that the frequency of the fundamental functions be very high and that the considered phenomenon be nearly stationary in relation to this frequency. De Broglie, however, has shown that, given the wave-equation

$$\nabla^2\psi - \frac{1}{c^2}\frac{\partial^2\psi}{\partial t^2} - \frac{4\pi^2}{c^2}\nu_0{}^2\psi = 0,$$

putting in the place of the function ψ the two $\psi_1 = \frac{A}{r}\cos 2\pi\nu_0 t$, $\psi_2 = B\sin 2\pi\nu_0 t$, and introducing the potentials

$$a_x = \tfrac{1}{2}\left[\psi_1\frac{\partial\psi_2}{\partial x} - \psi_2\frac{\partial\psi_1}{\partial x}\right], \quad . \; . \; . \quad \phi = -\frac{1}{2c}\left[\psi_1\frac{\partial\psi_2}{\partial t} - \psi_2\frac{\partial\psi_1}{\partial t}\right],$$

the results verify Lorentz's equation

$$\frac{\partial a_x}{\partial x} + \frac{\partial a_y}{\partial y} + \frac{\partial a_z}{\partial z} + \frac{1}{c}\frac{\partial\phi}{\partial t} = 0.$$

We thus obtain for the fields **E** and **H** the expressions

$$\mathbf{E} = -k \text{ grad. } \frac{1}{r}(1 + \cos 4\pi\nu_0 t), \quad \mathbf{H} = 0,$$

that is, the characteristic values of a pole of charge k.

With this new aspect of the theory, though on one hand the two functions ψ_1 and ψ_2 have no longer the properties of ψ and $\bar{\psi}$, on the other there is the advantage of correlating wave mechanics with Maxwell's theory. We may note that, using the above proceeding, it is possible to introduce the spinning electron into this theory. To do so, it should be observed that two quantities ψ_1 and ψ_2 are sufficient, according to Bateman and de Broglie, to produce the electromagnetic field; let us see if it is not better to introduce two four vectors, the components of which would be

$$\psi_{1x} = \frac{A_x}{r}\cos 2\pi\nu_0 t, \quad . \; . \; . \quad \psi_{1l} = \frac{A_l}{r}\cos 2\pi\nu_0 t,$$

$$\psi_{2x} = B_x \sin 2\pi\nu_0 t, \quad . \; . \; . \quad \psi_{2l} = B_l \sin 2\pi\nu_0 t \; (l = ct).$$

By this four vector we form a single four vector U such as

$$U_i = \tfrac{1}{2}\left[\psi_{1i}\frac{\partial\psi_{2i}}{\partial l} - \psi_{2i}\frac{\partial\psi_{1i}}{\partial l}\right] = \frac{\pi\nu_0}{c}\,\frac{A_iB_i}{r},$$

or putting

$$U_x = \frac{m_x}{r} = \frac{\pi\nu_0}{c}\,\frac{A_xB_x}{r}, \quad . \; . \; . \quad U_l = \frac{q}{r} = \frac{\pi\nu_0}{c}\,\frac{A_lB_l}{r},$$

we find that the three special components of the four vector U form a vector $\mathbf{m}/r$, while the fourth component is q/r.

If we now put

$$\mathbf{a} = \text{curl } \frac{\mathbf{m}}{r}, \quad \phi = \frac{q}{r}.$$

it follows easily that

$$\frac{\partial a_x}{\partial x} + \frac{\partial a_y}{\partial y} + \frac{\partial a_z}{\partial z} + \frac{1}{c}\frac{\partial\phi}{\partial t} = 0,$$

and the expressions of the electrical and magnetic fields are

$$\mathbf{E} = -\text{grad. } \phi = -q \text{ grad. } \frac{1}{r},$$

$$\mathbf{H} = \text{curl } \mathbf{a} = \text{curl}\left[\mathbf{m}, \text{grad. } \frac{1}{r}\right];$$

that is, the field produced by a spinning charge q which is equivalent for the magnetic field to a magnetic dipol **m**.

ANTONIO CARRELLI.

Istituto Fisico R. Università,
Napoli, Feb. 6.

Photochemical Decomposition of Hydrogen Iodide.

THE mechanism proposed by Warburg (*Sitz. der preuss. Akad. der Wiss.*, 300; 1918) for the photochemical decomposition of hydrogen iodide, namely:

$$\begin{aligned}
&(1)\; \mathrm{HI} + h\nu = \mathrm{H} + \mathrm{I}\\
&(2)\; \mathrm{H} + \mathrm{HI} = \mathrm{H_2} + \mathrm{I}\\
&(3)\; \mathrm{I} + \mathrm{I} = \mathrm{I_2},
\end{aligned}$$

has been generally accepted for a long time but has not received experimental confirmation. Warburg obtained a quantum efficiency of two and showed thermodynamically that reaction (2) was the only secondary reaction possible. Reaction chains cannot be set up in view of the non-occurrence of the highly endothermic reaction,

$$\mathrm{I} + \mathrm{HI} = \mathrm{I_2} + \mathrm{H},$$

which thus interrupts the chain.

Still another interpretation is possible, namely, that discussed by Stern and Volmer (*Z. Wiss. Phot.*, 19, 275; 1920), which leads to the same result of two molecules decomposing for each quantum absorbed. Here an activated molecule in colliding with a normal molecule brings about the decomposition of both.

$$(1)\; \mathrm{HI} + h\nu = \mathrm{HI}' \qquad (2)\; \mathrm{HI}' + \mathrm{HI} = \mathrm{H_2} + \mathrm{I_2}.$$

Until now no observation admits of a decision between these two possibilities, since Warburg worked at rather high pressures.

The writer purposed studying the quantum efficiencies at pressures sufficiently low so that a molecule of hydrogen iodide activated by absorbed radiation cannot make a collision with another molecule before its mean free life, namely, 10^{-7} sec. has terminated or before it decomposes of its own accord. In the former case, if reversion takes place, that is, if collisions are a necessary requisite for decomposition, one should expect the quantum efficiency to be very small, of the order 100 to 200 quanta absorbed per molecule decomposing. In the latter case, if it decomposes in a single act, the quantum efficiency should still remain two as at high pressures. The results are markedly different, and it should be easy to distinguish between these alternatives.

Using the 2080 Å.U. and 2530 Å.U. bands of the condensed zinc spark and working at pressure of hydrogen iodide of the order of 0·1 mm. mercury, well below the critical collision frequency pressure, the writer has found the quantum efficiency to be in the neighbourhood of two. The reaction was studied in its initial stages to avoid secondary absorption by iodine set free. The amount of decomposition was ascertained by freezing out all the hydrogen iodide and iodine, and measuring the hydrogen with a calibrated bifilar quartz manometer described by Coolidge (*J. Am. Chem. Soc.*, 45, 1637; 1923).

Thus Warburg's mechanism is substantiated experimentally. Further, this is the first time it has been proved that a polar molecule may dissociate in a single elementary act, thus affording a possible explanation of the continuous absorption spectrum of hydrogen iodide found recently by Tingey and Gerke (*J. Am. Chem. Soc.*, 48, 1838; 1926), and Bonhoeffer and Steiner (*Z. Phys. Chem.*, 122, 287; 1926).

The work is being continued and a more complete account will be published shortly.

BERNARD LEWIS.
(National Research Fellow.)

School of Chemistry,
University of Minnesota, Feb. 26.

The Tomb of Laplace

To those interested in the records and memorials of men of science, Paris, no less than London, presents a most attractive field for exploration. The Sorbonne, the Natural History Museum, the Observatory, the schools, the streets, the squares, and the churches abound with statues and monuments, while here and there can be traced the footsteps of such as Pascal, Lavoisier, and Pasteur. No spot, however, recalls such a wealth of historic associations as that of the famous Père Lachaise-cemetery, where, to mention only those famed in science, lie Delambre, Arago, Bichat, Cuvier, Charles, Brongniart, St. Hilaire, Comte, Chasles, and a score more. It was here also Laplace was buried, and his funeral discourses were pronounced by Daru, Biot, and Poisson. Over his grave was erected, a marble monument ornamented with a star and bearing the names of his great works.

For sixty-one years Laplace lay here, but in accordance with the express wish of his son, in September 1888 his remains were exhumed and re-interred in the grounds of the family estate at Saint Julien de Mailloc, Calvados. The removal seems to have attracted little attention even in scientific circles, and in view of the interest aroused by the centenary of the death of Laplace the following particulars are perhaps worth recording. For them I am indebted to the Comte de Colbert-Laplace, a great grandson of the famous astronomer, who also informs me that on Dec. 11, 1925, a fire completely destroyed the chateau de Mailloc, and with this were lost all the papers and personal relics of Laplace.

Saint Julien de Mailloc is a small hamlet situated between Lisieux and Orbec, Calvados; and it is on a by-road leading from the main road joining those two places that the tomb of Laplace is to be found. Erected in 1887, it is in the form of a Greek temple about fifteen metres high. The inscriptions recall the birth and death of Laplace, his "Mécanique Céleste," "Système du Monde," and "Théorie Analytique des Probabilités." In a bronze urn in the interior is the heart of Laplace, while the tomb also shelters the remains of his wife, his son, his daughter, and other descendants. Laplace's son, Charles-Emile-Pierre Joseph, Marquis de Laplace, who became a general of artillery, died at the age of eighty-four in 1874, but it was he who desired that Laplace should be brought to Calvados. At the time of the reinterment, the monument which had stood for sixty years in the Père Lachaise, was given to the commune of Beaumont-en-Auge, where Laplace was born, and was re-erected in the cemetery there.

In view of the complete destruction of the papers of Laplace in 1925, it may not be out of place to recall that in Nature of June 8, 1871, p. 108, is a note to the effect that housebreakers raided Laplace's old chateau at Arcueil and threw the manuscript of the "Mécanique Céleste" into the River Bièvre, from which, however, it was rescued.

Edgar C. Smith.

Science Museum,
South Kensington, S.W.7.

Tetragonal Structure of Carbon Steel.

It has been shown by Westgren, Vewer, and many others that the martensite of carbon steel has only the crystal structure of α iron, and sometimes has simultaneous structures of α and γ iron with carbon in the state of solid solution. Recently Fink and Campbell (*Transactions of the American Society of Steel Treating*, 9, 717; 1926) found the body-centred tetragonal structure with a ratio of axes 1·06 in carbon steel (1·5 per cent. carbon) after quenching in water from 940° C. Our investigations of carbon steel quenching in water show also the body-centred tetragonal structure. The following table gives the carbon content, the temperature of quenching T, the ratio of axes $c = a/b$, and their dimensions a and b:

Per cent.	T. °C.	c.	a. 10^8 cm.	b. 10^8 cm
0 8	1100	1·027	2 851	2·920
1·0	1100	1·051	2·843	2·987
1·2	1000	1·058	2·848	3·010

In the samples of steel having 0·8 and 1 per cent. carbon in addition to the tetragonal structure were found γ iron (in the sample of steel which had 1 per cent. carbon there was no α iron).

From the above table we arrive at the conclusion that the observed tetragonal structure of steel is a solid solution of carbon in the body-centred tetragonal lattice of metal atoms. It is probable that the martensite has always a body-centred tetragonal structure (simultaneously there could be α and γ iron).

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N. Goodtzov.

The Metallurgical Laboratory of
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Feb. 9.

Early British Patent Grants.

The contributor of the "Calendar of Discovery and Invention" appearing in the pages of Nature has in the issue for Feb. 26 fallen into a not uncommon error, when he records Mar. 2, 1617, as the date of the first British patent for invention. This certainly is not the case. The reasons that caused the then Commissioners of Patents to start the famous official series of English patents with the year 1617 were purely fortuitous, and in no way endow this particular patent with any special claim to immortality. The researches of Mr. Hulme and others have brought to light a large number of earlier grants, mostly by Elizabeth and James I., but including one (that to John of Utynam for the making of coloured glass) so early as 1449, and it is to this one that the distinction of priority must for the moment be given.

Moreover, the Statute of Monopolies cannot be correctly described as for the first time securing "the sole working or making of any manner of new manufacture within this realm to the true and first inventor." The Statute was passed simply to prevent the Crown making vexatious monopoly grants; it initiated nothing, and expressly exempted from its operation the use of the existing prerogative in respect of new inventions, a prerogative which, as we have seen, had been constantly exercised for many years past.

Allan Gomme.
(Librarian.)

The Patent Office Library,
25 Southampton Buildings,
London, W.C.2.

Prehistoric Archæology in Yorkshire.

In Nature of Mar. 5, p. 364, announcement is made of the proposed formation of an 'out door' museum at Easington, Yorks, by the East Riding Antiquarian Society. The exhibition of 'obsolete farming appliances' is no doubt a praiseworthy object; but one is tempted to inquire when the Mortimer collection is to become accessible for study by those interested in prehistoric archæology? This collection represents the life's work of the late J. R. Mortimer, who excavated a very large number of barrows on the Yorkshire wolds. It ranks with similar collections at Devizes and in the British Museum; but it has not even been seen by most of the present generation of archæologists, including the present writer. The collection is of national importance, and if the people of Yorkshire do not appreciate their good fortune in possessing it, they should hand it over to others who do. A collection in packing-cases is of no use to any one.

O. G. S. Crawford.

Ordnance Survey Office,
Southampton, Mar. 10.

The Centenary of the Friction Match.

By Prof. William A. Bone, F.R.S.

Exactly a hundred years ago next Thursday, John Walker, pharmacist of Stockton-on-Tees, recorded in his Day-Book the first credit sale of his newly-invented 'Friction Lights,' which were indisputably the first practical and useful friction matches. This historic record was as follows:

"*Die Saturni Apr. 7th* 1827
No. 30
Mr. Hixon
Sulphurata Hyperoxygenata Frict. 100
Tin Case 2*d*. 1. 2."

There are few scientific inventions which have been more saving of time and trouble to Mr. Everyman, or more generally used the world over, than that of the humble friction match. It is now so cheap and ubiquitous that to offer a light to a stranger on a railway journey is perhaps the commonest of everyday courtesies amongst all classes of society. No one feels the cost of matches; they are supplied gratis almost everywhere, and the vast number wasted passes unnoticed: truly a 'universal aid,' without which we should be thrown back to the inconveniences of the good old 'flint and tinder' days.

John Walker, to whose memory honour is due to-day, was born at Stockton-on-Tees in 1781 and died there in 1857; my grandfather (the late Thomas Hutchinson, *d.* 1893) knew him well. A memoir published by Dr. R. W. Foss ("Archæologia Æliana," vol. 7) says that as a youth he was articled to Mr. Watson Alcock, surgeon of his native town, and that, after completing his apprenticeship, he went to London (doubtless as a student) for a few years, returning to become Mr. Alcock's assistant.

It was during his apprenticeship that John Walker first began to show his scientific proclivities. He was constantly making chemical experiments, attained considerable reputation in the locality as a botanist, and later on took up the study of mineralogy, in which he became very proficient. After his invention of friction matches (or 'friction lights' as he usually called them) had brought him wider fame, as well as the prospect of a fortune, he steadily refused to patent it, being (as Dr. Foss remarked) "a studious, retiring man, caring more to pursue his scientific studies, whether botanising or experimenting in chemistry, than speculating in order to make money."

Although qualified as a surgeon, "an invincible horror to surgical operations," which he never was able to overcome, soon led Walker to abandon that profession, whereupon he spent some years in Durham and York acquiring commercial experience in the employment of wholesale druggists. Eventually, in 1819, at the age of thirty-eight years, he returned to his native town, where he established himself in business as a pharmacist, at No. 59 in the High Street (since 1896 marked by a suitably engraved brass-plate), living in a house on the Quayside, then a pleasant locality but now much dilapidated. Thirty years later he retired from business, having acquired sufficient for all his needs. He died in 1857 at Stockton-on-Tees, and was buried in the churchyard of the neighbouring parish of Norton-on-Tees, where an unpretentious stone marks his grave.

Walker was never married, but lived with a niece who survived him more than thirty years. He was described by a contemporary as "a trim, dapper, little man," of cheery disposition and ready wit; a man rather particular as to fashion in dress, well known at the time of his invention by his brown tail-coat, drab knee-breeches, grey stockings, white cravat and tall beaver hat.

For many years, how Walker came by his invention was scarcely known. According to an account published in a local newspaper in 1852, it was the result of chance. "Mr. Walker was preparing some lighting mixture for his own use when a match, after being dipped in the preparation, took fire by accidental friction on the hearth . . . and the hint was not lost." Also, Dr. Foss said, "On one occasion . . . some chemical mixture he had compounded fell upon the hearthstone and ignited . . ."; moreover, that Walker did not divulge the exact chemical composition of his matches, and that "from a careful search which has been made in his books it has not been possible to find it. . . ." Such, then, was the local tradition more than fifty years ago.

About the year 1890, however, an old Day-Book in Walker's own handwriting was found among a heap of other papers relating to his pharmaceutical business, which gave a new clue as to how he made the invention. This Day-Book covered the period from Aug. 9, 1825, to Sept. 22, 1829, inclusive, during which time the invention was made. It was handed over to me for investigation (1896) together with eight matches, which undoubtedly had been purchased of Walker himself sometime not later than November 1827. I copied all the relevant entries from the book, and made an analysis of the tip of one of the matches, which confirmed a then current belief that he had used a mixture of potassium chlorate and antimony sulphide made into a paste with gum and starch.

The Day-Book also revealed that, so early as 1825, Walker had been selling a mixture of equal parts of potassium chlorate and antimony sulphide to three different persons, but chiefly to a Mr. Vollum, Junr., of Hartlepool. Entries of such sales continued until Dec. 6, 1828, quite independently of those of his 'friction lights,' the first being as follows:

"*Die Saturni Nov.* 19 1825
Mr. Walton Jr. Norton
by Potassa Chlorat. 3 j Ant. sul. nigri 3 j
Muc. g. i. Aqua q. s. ft. pasta
N.B. Excellent. 1. 6."

The "N.B. Excellent" suggests that the composition in question had been made up *experimentally* for some purpose, which had been well answered. There is also strong evidence in the Day-Book that the purpose was percussion powder, because (1), there are six entries during the years 1826–8 of the Mr. Vollum in question purchasing a composition described either as "pulv. percuss" or as a mixture of equal parts of antimony sulphide and potassium chlorate, the name of Vollum not occurring in any other connexion; and (2), all these six entries, as well as the only two others relating to the purchase of such material during the years covered by the book, were in the autumn or early winter months (September to January), when game-shooting is practised, no such entry ever having been made during any other time of year.

Two entries in the book (dated July 26, 1827, and Sept. 12, 1828, respectively) refer to sales to a Mrs. Faber of "*oxygent*^{d}. *matches*" tipped (as is recorded) with chlorate of potash and sugar only. Undoubtedly these refer to the 'oxymuriate or dipping matches' (strips of wood tipped with a mixture of chlorate of potash, sugar and gum, and ignited by contact with strong sulphuric acid) invented by Chancel in 1805, which had been fairly widely used since 1812.

Therefore it seems reasonable to suppose (1), that Walker had occasionally made Chancel's 'oxymuriate matches' to the order of at least one of his customers; (2), that so early as 1825, if not before, he was experimenting on the production of a sporting 'percussion powder,' composed of equal parts of chlorate of potash and antimony sulphide, for certain other customers, more particularly Vollum; and (3) that, having succeeded, it occurred to him to produce a *friction* match by substituting the same composition for the mixture of potassium chlorate and sugar used for tipping the Chancel *dipping* match. It is important also to observe (4) that he never used the term 'matches' in reference to his own invention, which he usually called 'friction lights' (sometimes, however, 'attrition lights'), and (5), that in the first entry in the book of their sale (*q.v.*), there occur the words "No. 30," probably signifying (as I think) the batch-number of the friction lights in question. If this surmise be correct, he probably had been making them for some time prior to the first recorded sale, which (be it noted) was a credit, and not a cash, transaction.

Walker's 'friction lights' were thin splints of wood, three inches long, one-sixth inch broad, and one-twentieth inch thick, tipped with the aforesaid composition of equal parts of antimony sulphide and potassium chlorate, as my analysis has shown. They were sold by him at 100 for a shilling, in a cylindrical tin case, for which he charged an extra twopence (or a shilling for 84 lights *plus* case). With each case was supplied a piece of 'glass-paper,' folded in two, and a 'light' was ignited by pinching its head between the folds, and then suddenly withdrawing it.

In the Day-Book are entered 23 credit sales of friction lights during 1827, 76 during 1828, and 69 during 1829, or 168 altogether. By the year 1829 their fame had reached London; it is said that Faraday had exhibited some of them at a lecture in London "which set the scientific world thinking."

In that year, also, the following notice of them appeared in the *Quarterly Journal of Science, Literature, and Art*, under the title of "Instantaneous Light Apparatus." "Amongst the different methods invented in latter times for obtaining a light instantly ought certainly to be recorded that of Mr. Walker, chemist, Stockton-on-Tees. He supplies the purchaser with prepared matches, which are put up in tin boxes, but are not liable to change in the atmosphere, and also with a piece of fine glass-paper folded in two. Even a strong blow will not inflame the matches, because of the softness of the wood underneath, nor does rubbing upon wood or any common substance produce any effect except that of spoiling the match; but when one is pinched between the folds of the glass-paper, and suddenly drawn out, it is instantly inflamed. . . ." From 1829–30 onwards, Samuel Jones, of 201 Strand, London, made and sold imitations of them as 'lucifers' (a name which Walker always repudiated), saying that they had been "lectured on at the London and Royal Institutions." It is said that Walker, who was always very modest about his invention, even to the extent of thinking it unimportant, did not long afterwards continue to make 'friction lights.'

Such, then, were the nature and circumstances of this most useful invention. Before many years had passed, other claimants to it arose. At one time the late Sir Isaac Holden thought himself to be the original inventor of 'friction matches,' but in a letter which he wrote to the late Mr. Joseph Parrott of Stockton-on-Tees on Feb. 3, 1894 (*after* hearing of the discovery of Walker's Day-Book), of which I have a photograph, he said, "My invention, if so it may be called, was introduced by me in Oct. 1829 in *entire ignorance* of Mr. Walker's." Unfortunately, the Report of Juries of the Exhibition of 1851 contained a judgment by Warren de la Rue and A. W. Hofmann that "The first friction matches or congreves made their appearance about 1832," without even mentioning Walker's prior invention Now the 'congreves,' which were introduced into England from Germany and Austria in that year, were originally invented by a young French chemist, Charles Sauria of St. Lothair (*d.* 1895), who in January 1831 (or nearly four years after Walker's invention), whilst a student at the Collège d'Arc, Dole (Jura), made friction matches containing phosphorus, but (like Walker) he did not patent his invention, which some think was pirated in Germany. In 1884 the French Government recognised Sauria's 'l'Invention des Allumettes Chimiques' by appropriately granting him a 'bureau de tabac'; and a medal was also bestowed upon him by the Academie Nationale Agricole. Unfortunately, except that in 1913 *Punch* published some verses in his honour, so far nothing has yet been done in Great Britain to recognise or commemorate John Walker's invention; but its centenary affords the opportunity of removing this reproach.

Activities of the Medical Research Council.

PERUSAL of the report of the Medical Research Council for 1925–1926,[1] as usual, gives the reader a bird's-eye view of much of the research work which has been carried out in Great Britain on medical and allied subjects during this period. By the system of grants-in-aid to workers in university and hospital laboratories, etc., the Council is enabled to promote research on a much wider variety of subjects than would otherwise be possible; in fact, almost two-thirds of the Parliamentary grant of £135,000 was utilised in this manner, the greater part of the remainder being devoted to the expenses of the National Institute at Hampstead and of the farm laboratories at Mill Hill. Only a few of the more salient points of the report can be touched on in this short account.

Before referring to the scientific work, attention may be directed to certain events of the year which affected the Council. By an Order in Council in July the constitution of the Committee of the Privy Council for Medical Research was altered and the Committee now consists of the Lord President of the Council, the Secretaries of State for Home and Dominion Affairs, for the Colonies, and for Scotland, and the Minister of Health. A few months previously an alteration of the charter of the Medical Research Council had been approved; the amendments provided, *inter alia*, for an increase in the numbers of the Council from ten to eleven, of whom eight are appointed in respect of their scientific attainments, whilst the remaining three include a representative from each of the Houses of Parliament. Two of the former retire each year and are not eligible for immediate reappointment, whilst one of the latter group retires every two years but is eligible for immediate reappointment.

During the year also, the Committee of Civil Research was set up to provide for the discussion of problems which are common to more than one field of science, or to more than one part of the Empire. In addition, representatives of the Medical Research Council were appointed members of the Research Special Sub-Committee of the Imperial Conference and took part in the deliberations of this Committee.

PHYSIOLOGICAL AND BIOCHEMICAL INVESTIGATIONS.

Insulin.—Since the original discovery of insulin by Banting and Best, the problem of the fate of the sugar which disappears under its action from the blood has led to much speculation and stimulated numerous researches, without reaching a final solution until last year. It was known that in the diabetic organism, insulin produced a storage of glycogen in the liver, but in the normal animal the disappearance of sugar from the blood was usually accompanied also by a decrease in the glycogen of this organ; at the same time, examination of the respiratory exchange had shown that, although the metabolism became predominantly carbohydrate in type, yet the oxygen consumption was not sufficiently increased—it might even be decreased—to account for the combustion of all the sugar vanishing. A brilliant series of researches at the National Institute during the past year appears now to have solved this problem.

C. H. Best, in a preliminary investigation on artificially perfused limbs, was able to show that the skeletal muscles were the chief site of the disappearance of sugar. Working with J. P. Hoet and H. P. Marks, he then found that a large part of the glucose disappearing could be found as glycogen in the muscles; although the inorganic phosphate of the blood falls together with the sugar, no storage of phosphoric esters in the muscles was observed. Finally, Best, Dale, Hoet and Marks made a complete balance-sheet of the glucose exchange under the action of insulin. Under all conditions of glucose supply in relation to the dose of insulin, the total amount of glucose disappearing from the system—the decapitated eviscerated preparation—was equal to that burnt, as estimated from the oxygen consumption, together with that found deposited as glycogen in the muscles.

The loss of glycogen from the normal liver under the action of insulin is a secondary effect of the fall in the blood-sugar. In the diabetic with a high blood-sugar, insulin promotes glycogen deposition in the liver, but under its continued action, with a fall in the blood-sugar below a critical level, this glycogen will be transferred, as sugar, to the muscles. The liver glycogen acts as a carbohydrate reservoir, easily available if the blood-sugar falls; muscle glycogen, on the other hand, does not appear to have this function. The depression of the total metabolism under the action of insulin, mentioned above, is most easily explained on the assumption that insulin restrains the new formation of carbohydrate from protein, or fat (Burn and Marks), in the liver. It may therefore be concluded that the action of insulin is identical in both the normal and the diabetic organism.

A very interesting observation has been made by Hoet and Marks, as an incidental outcome of this work on insulin. It has been known for some time that animals dying from an overdose become rigid almost immediately. This also occurs when a rabbit dies after daily thyroid feeding for some weeks. In both cases there is almost complete exhaustion of the muscle glycogen; the *rigor mortis* sets in also whilst the muscles are still alkaline. It appears that the rigidity is due to a failure to reform the hexose-phosphate or 'lactacidogen,' from a shortage of the raw material, the glycogen. Under ordinary conditions the muscle enters into *rigor* only some time after death, and with an acid reaction; in this case the cause must be sought in the death of the synthetic mechanism.

Histamine.—Since the discovery by Dale, Laidlaw, and Richards that histamine, whilst stimulating smooth muscle, relaxes the walls of the capillaries, leading to a marked fall of blood pressure, interest in this substance has been maintained, more especially since it was probably responsible for many of the cases of 'shock' seen during the War. More recently it has been suggested that it may have therapeutic applications. It has been known for many years that extracts of most tissues cause a fall in the blood pressure; recently a liver extract has been advocated as a therapeutic measure in high blood pressure in man. Best, Dale, Dudley and Thorpe have succeeded in identifying the active principles of liver extracts and have found them to be histamine and choline. In addition, large amounts of histamine have been extracted from fresh lungs, *e.g.* 0·3 gm. from 10 kgm. of lung. It must be remembered in connexion with these quantities that 1 part in 250 million parts of water can produce contraction of the smooth muscle of the uterus.

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[1] Committee of the Privy Council for Medical Research. Report of the Medical Research Council for the Year 1925–1926. Pp. 161. (London: H.M. Stationery Office, 1926.) 3*s*. 6*d*. net.

The physiological function of histamine in the body is still a subject for research, but it may be suggested that it plays a part in the chemical control of the capillary circulation, perhaps as an antagonist to adrenaline. This suggestion is supported by the work of Sir Thomas Lewis and his colleagues; they have found that the local reaction of the skin blood-vessels to irritation or injury can be exactly imitated by the injection of minute amounts of histamine.

BACTERIOLOGICAL INVESTIGATIONS.

Cancer.—The work of Gye and Barnard on the filter-passing virus of cancer has been continued. It will be remembered that Gye, working with the Rous chicken sarcoma, found evidence which he believed could only be explained on the hypothesis that the cell-free filtrate from the tumour contained two factors, either of which alone was innocuous. One was a thermolabile substance, specific to the species from which the material was derived; the other was a filter-passing virus, which could be obtained also from mammalian tumours. Gye's recent work has confirmed his original observations; thus he has been able to destroy the virus by using antiseptics like acriflavine or cyanides, instead of chloroform, leaving the specific factor intact in the solution. Some parts of his work have been confirmed by other investigators, other parts are unconfirmed or the validity of his evidence denied. Only further experiments can settle the conflict of testimony.

Dog Distemper.—P. P. Laidlaw and G. W. Dunkin have continued their investigations into canine distemper; the work is greatly aided by the fund collected by the *Field* newspaper. It is now quite certain that the disease is caused by a filter-passing virus; unfortunately, no means have yet been discovered of cultivating it *in vitro*. It can, however, be transmitted to ferrets and back again to dogs at will. The ferret can be immunised by inoculation with formalin-treated virus and is then usually protected against what is an almost invariably fatal disease in this animal. On the other hand, attempts to immunise dogs have been less successful; but it is hoped that a primary inoculation of dead virus followed by a mild distemper infection while the animal is refractory to the disease, will develop sufficient resistance to protect the animal against chance infections.

Chemotherapeutics.—In conclusion, attention may be briefly turned to one or two chemotherapeutical investigations. S. R. Douglas has shown that sanocrysin (sodium gold thiosulphate) has not a specific action on the tubercle bacillus, but so affects the cells of the tubercular lesions as to give indirect damage to the infecting organisms; in rabbits, S. L. Cummins has found that mild infections can be eliminated by this drug, but heavy or virulent infections cannot be cured. In another direction Dobell and Laidlaw, utilising their method of cultivating entamœbæ *in vitro*, on media containing solid rice-starch, have shown that emetine and cephæline are specifically poisonous to *E. histolytica*, the causal organism of amœbic dysentery in man. Minute quantities inhibit its growth and ultimately destroy it, but relatively strong concentrations are necessary to kill it at once. The importance of this time factor in the treatment of the human disease is obvious.

Obituary.

DR. A. W. CROSSLEY, C.M.G., C.B.E., F.R.S.

DR. ARTHUR WILLIAM CROSSLEY, who died at his residence, Thorngrove, Alderley Edge, Cheshire, on Saturday, Mar. 5, at the relatively early age of fifty-eight years, was the son of the late Richard Crossley and was born at Accrington on Feb. 25, 1869. His early education was obtained at Mill Hill School, from whence he proceeded to the Owens College, Manchester, then part of the federated Victoria University, where he graduated in the honours school in 1890. It is evident that thus early in his career his tastes inclined towards the organic side of chemistry because, after graduating, he went to Würzburg to work under Emil Fischer, then well on the way towards the zenith of his fame, and from there published his first paper, a short note on the optical behaviour of dulcitol, in 1892. He graduated Ph.D. at Würzburg in 1892 and then followed Fischer to Berlin, from which University he published his second paper, on the oxidation of mucic acid, in 1894.

In the autumn of 1894, Crossley returned to Manchester to work with the younger Perkin, who had two years previously succeeded Schorlemmer in the chair of organic chemistry and had started the Manchester school of organic research, which was afterwards to become world famous. He was awarded a Bishop Berkeley fellowship, which, however, he relinquished in the following year on his appointment as lecturer in chemistry at St. Thomas's Hospital; nevertheless, during his short stay in Manchester, he completed an important paper on the substituted pimelic acids, which he published conjointly with Prof. Perkin in 1895. During the time he remained at St. Thomas's Hospital, that is, until 1904, when he was appointed professor of chemistry to the Pharmaceutical Society of Great Britain, he published several papers on the malonic ester condensation, mainly in connexion with the formation of hydro-aromatic compounds. This work was evidently the outcome of that which he had started earlier with Perkin on the constitution of camphor—a problem at that time occupying the full attention of Perkin's school at Manchester. It appears that Crossley completed this camphor work at St. Thomas's, for it is embodied in a paper on dihydrocamphoric acid published with Perkin in 1898, and that, moreover, the peculiar properties of dihydrocamphoric acid decided him to subject a whole series of hydro-aromatic substances to special investigation.

In this way Crossley's life work, so far as organic chemistry is concerned, was determined, and we find a number of papers from his pen appearing at regular intervals from 1896 until 1914, in which year he was appointed Daniell professor of chemistry at King's College (University of London). The insight and manipulative skill shown by these researches place Crossley in the front rank of modern organic chemists and would have enabled him to accomplish far greater achievements had not fate determined otherwise, for the advent of the War directed his energies into other channels of wider and more urgent importance. During his stay at St. Thomas's Hospital he was associated in his research work with Henry Rondel Le Sueur, and while at the Pharmaceutical Society, with Charles Gilling and Nora Renouf, with whom he published many important papers. He was awarded the D.Sc. of the Victoria University in 1899, and was elected fellow of the Royal Society in 1907. He received the Longstaff medal of the Chemical Society in 1918.

Shortly after the outbreak of War, the Royal Society formed a committee to render the Government any assistance that might be necessary on the scientific side, but after the first definite use of gas in April 1915, it was evident that special measures would have to be taken to meet the new menace. On the formation of the Trench Warfare Department under Colonel (now General Sir Louis) Jackson, Crossley was nominated by the Royal Society as a member of the Advisory Committee of the Department and became its first secretary. Early in 1916 it was realised that the trench warfare experimental grounds at Clapham Common and Wembley were too small for the purposes of large-scale experiments, and were, moreover, situated in areas too congested to warrant the use of materials likely to be dangerous to health. Search led to the discovery of a tract of land of poor agricultural value situated between the London Road and the railway about two miles from Porton in Wiltshire, and here, in the spring of 1916, it was decided to establish an experimental station for investigations in connexion with chemical warfare.

The problems requiring solution were urgent and complex, the power and safety of our armies in the field depending upon the provision of offensive and defensive appliances in the shortest possible time. Nothing existed on the ground but a few farm buildings and out-houses, and everything from a gun range to a drainage system had to be provided as quickly as possible. Crossley undertook to put things in order, and for this purpose he was given the rank of Lieutenant-Colonel R.E. Here, then, with a band of devoted helpers, he started to carry through what was in all probability the most difficult task of his life, requiring as it did the exercise of infinite tact and a power of control over men such as few, especially those trained in academic surroundings, possess. It was, indeed, a prospect which the boldest might have hesitated to face. Nevertheless, Crossley played his part as a soldier with all the energy and force with which he did everything else, and brought to bear a personal charm of manner which enabled him, although a strict disciplinarian, to endear himself to all the officers and civilians serving under him. It was due to him and those with him that within a comparatively short space of time the experimental station at Porton became a real factor in the War, and that it was established on a basis which not only caused it to be the centre of chemical warfare research in Great Britain, but also enabled it to serve as a model on which similar organisations have been built in other countries.

It was the present writer's lot to form one of the group of five who walked from the London Road into that peaceful valley one Sunday in February 1916, and also to be one of those who was present when His Majesty the King visited the station in 1918. No one who has not undergone these two experiences can realise the change Crossley had wrought in the time. For some considerable period he acted as liaison officer with the French and he visited the front on many occasions. His work also necessitated frequent consultations with the chemical advisers to the armies, and for this purpose he made many visits to St. Omer and Paris Plage. Later, the increase of work at Porton required his full attention and he delegated his French work to others. For his services to the French Government he was created an Officier de la Légion d'Honneur on the occasion of the visit of the Chemical Warfare Advisory Committee, which had now become part of the Ministry of Munitions, to Paris. He was created C.M.G. in 1917, and C.B.E. in 1919.

During the War the Department of Scientific and Industrial Research, which had been established as a Committee of the Privy Council in 1915, decided to form industrial research associations in order that, after the War, there might be an organised effort, backed by the latest scientific methods, to meet the competition which would then arise. Among these, one of the latest to be formed was that constituted in 1919, dealing with the cotton industry, for which, in the following year, the house at Didsbury, Manchester, afterwards known as the Shirley Institute, was acquired. Crossley was appointed first Director of the Association, and here, as at Porton, he was faced with the problem of creating an organisation from the beginning. The Shirley Institute comprised a large private house situated in its own grounds but bearing no semblance to a scientific institution. He had to undertake the difficult task of installing laboratories and equipment which could deal effectively with the problems arising in this basic industry. Such problems would necessarily cover a wide field, including many branches of science, and would, therefore, entail the initiation and control of researches in subjects other than chemistry. He had not only to help the industry by research on scientific lines, but also had to accomplish the still more delicate task of appealing by the work of the Institute to those who were anxious for immediate practical results and were not always cognisant of the essential need for fundamental research as a foundation for industrial progress. It is a remarkable fact that in two years, that is to say, in approximately the same time as was taken to organise Porton, the Shirley Institute was established as a fully equipped research unit and was formally opened by the Duke of York in 1922. Since then the volume of research work from the Institute has not only made it a model research association, but has also, by reason of the practical application of its work, convinced many who were previously sceptical of the value of fundamental research in relation to the industry.

Despite his many other activities, Crossley found time to devote himself to other public work, and was from 1903 until 1913 secretary of the Chemical Society and from 1913 until 1925 its foreign secretary. In the latter year he was president of the Society, but had to relinquish the office after one year owing to failing health. He was a man, therefore, who gave great and useful service to his country, and received the recognition of his King, his University, and his fellow scientific workers. Had he lived he would have attained to greater honours, for the full power of his work will not be realised until the lapse of time has proved its value. Without question his life was shortened by his devotion to public duty and by the strain imposed on his constitution by the high sense of responsibility he felt in all the work he undertook. The War years imposed a heavy burden, which, although cheerfully borne, nevertheless left its mark on a not too robust constitution, and he never seemed quite the same man afterwards. He was essentially a pioneer, for his great activity of mind led him to seek new problems as soon as he had settled the one in hand to his own satisfaction and had brought it to a stage at which he felt he could safely hand it over to others. He was denied, therefore, the complacent rest which ought to follow the contemplation of smoothly running administrative machinery well and truly constructed J. F. T.

M. F. E. Turpin.

M. François Eugène Turpin, well known as the inventor of melinite, one of the high explosives used in shell-filling, died on Jan. 24 at Pontoise. We are indebted to a recent issue of *La Nature* for the following particulars of his life. After his birth at Rosendael in 1849 his parents moved to Paris, where, on leaving school, he began to study medicine. But he became interested in chemical research, and it was not long before his natural skill in experimental work was publicly recognised by the bestowal upon him by the Paris Academy of Sciences of the Montyon prize for his invention of harmless colouring matters for children's toys. This invention presently involved him in some litigation, but, nothing daunted, he applied himself with energy to the study of explosives. Those were the days of black gunpowder, dynamite, and gun-cotton. The instability of nitrated organic compounds had rendered them unfit for use by the artillery and even unsafe to store in magazines. With the object of overcoming these difficulties Turpin decided to abandon the search for suitable material among aliphatic compounds and turned his attention to those of the aromatic series. After seven years of ceaseless toil he perfected a process for preparing a suitable high explosive from picric acid by the simple device of melting it in an oil-bath and running it into moulds. When, shortly afterwards, a suitable detonator had been devised for use with the new explosive, the French Government purchased the new process from him; but the secret appears to have been treacherously revealed to a British firm by an artillery officer, whom Turpin vigorously denounced in a volume entitled "Comment on a vendu la mélinite." For this indiscretion Turpin was prosecuted, and eventually condemned to prison on the charge of having revealed in his book secrets of importance to the national defence. After spending nearly two years in prison he was pardoned in 1893, and in 1901 he was completely restored to favour by being elected to serve as a technical adviser to the artillery. In this capacity he rendered invaluable service to France until after the War, when the State awarded him an annuity.

Prof. Carl Graebe, who died after a long illness on Jan. 19 in his native town, Frankfort, within a few weeks of completing his eighty-sixth year, had for many years occupied with distinction the chair of chemistry at Geneva. Graebe's reputation was made by his brilliant researches on the constitution of aromatic and heterocyclic compounds, particularly on quinones, phthalic acid, alizarin, and acridine. He also succeeded in demonstrating the constitution of anthracene, phenanthrene, fluorene, carbazol, etc., and was a pioneer in the investigation of the relationship between colour and chemical constitution. Having shown that alizarin was derived not from naphthalene but from anthracene, the synthesis of that important dyestuff could not be long delayed, and the solution of this problem in 1868 by Graebe and Liebermann marks an important stage in the development of the dyestuff industry. Graebe was also the author of a work on the history of organic chemistry.

News and Views.

There is now real ground for hope that a new measure for the protection of wild birds in Great Britain may reach the Statute Book within the next few months and so come into force on Jan. 1, 1928. The Wild Birds Protection Bill received a second reading in the House of Commons on Mar. 25, and is referred to a standing committee. Ever since the Departmental Committee on the subject reported in 1919, legislation on these lines has been pending. Several bills, not greatly differing from the present one, have been introduced, and have made progress in varying degree: they have eventually failed not through opposition but merely on account of the exigencies of parliamentary time. On this occasion the crucial stage has been survived, and if the Bill is given sympathetic treatment in committee, there should be no difficulty in its receiving a third reading and then passing through the House of Lords.

We published a full account of an earlier form of the measure two years ago (Nature, June 20, 1925, p. 934), and a brief indication of the scope of the present Bill will here suffice. Some general protection is given to all birds by the prohibition of destruction and capture by certain methods and at certain times and places. Special protection, further, is given to different species according to the categories in which they are classified for the purpose. Birds in Category I. and their nests and eggs are protected at all times. Birds in Category II, with their nests and eggs, are protected during the close season, normally Mar. 1–July 31. Birds in Category III., but not their nests or eggs, are protected during the close season except against the owner or occupier of the land or his agents. Named as coming within the first category are the greater rarities, some much persecuted species, and a few others: in the second are birds which especially need protection in the breeding season. The third category comprises all birds not scheduled as belonging to the first or second. The Bill will supersede the existing legislation on the subject. Its great merits are its simplicity, the uniformity which it will introduce, and the better powers given for enforcement. These should lead to a much greater effectiveness in practice.

It is noteworthy, from the report of the debate on the second reading of the Protection of Wild Birds Bill, that such opposition as there was, apart from points of detail which will be raised again in committee, mainly arose not from objection to the proposed provisions but from a desire for a still wider measure. The protection of all birds at all times, apart from such few species as might have to be blacklisted, was indeed suggested. The Bill as it stands, however, seems to achieve a wise moderation. It gives absolute protection where it is most needed, and some measure of protection to all birds: it avoids the unnecessary creation of new offences, and the imposition of excessive restrictions which would tend to alienate that public opinion upon which the successful working of a law of this kind must largely depend.

Among the great City Companies of London there is none more closely associated with pure and applied science than the Goldsmith's Company, which this week is celebrating the six-hundredth anniversary of its foundation. By a happy coincidence, the Prime Warden of the Company this year is Sir Dugald Clerk, who presided at the banquet held on Monday, and one of the Wardens is Sir William Pope, who will become Prime Warden the year after next. Other fellows of the Royal Society who have been Prime Wardens of the Company are Mr. George Matthey, Sir Frederick Bramwell, Sir Frederick Abel, Sir J. Wolfe Barry, and Mr. C. T. Heycock. In October last we described an extension of the City and Guilds (Engineering) College at South Kensington, provided by the munificence of the Company at a capital cost for building of £87,000. The Company also heads the list of grants made by city companies to the City and Guilds Institute with total grants amounting to £204,500, and these represent only part of the generous provision made by the Company for progressive education and science. We have often expressed appreciation of the encouraging attitude constantly displayed by the Company towards scientific activities, and we are glad to offer it our most cordial congratulations upon the wise purposes for which it employs its funds and upon the strength of its present position in national life.

The interesting collection of prehistoric stone implements from Suffolk, the South Downs, and other British localities formed by Mr. S. G. Hewlett during twenty-five years of personal collecting, has recently been sold at Stevens's auction rooms. Although dispersals are especially to be regretted when objects of local importance are thereby removed from their proper homes, they afford an excellent opportunity for appraising the value which the public sets upon the specialised collections and researches of others. Truth to tell, this sale has shown that these stony and enduring records of early but barbaric man are very far behind the ephemeral postage stamps of his civilised successors in the public estimation. No single implement fetched more than £3. Close on two hundred and fifty lots, comprising 6000 'flints,' passed under the hammer for a total of £293 : 9*s*. In detail, 287 palæoliths brought £25 : 4*s*., and 1076 neoliths, mostly from the eastern counties of England and the Thames Valley, brought £103 : 17*s*., an average of ten to a £1. Those from the South Downs, with others, were sold at about thirty to a £1, and some 300 from abroad only fetched £15 : 1*s*. For years we have been stimulated by the sight of long series of such specimens beautifully set out in museums in expensive cases, to wander across ploughed fields and gravel heaps looking in vain for flints that never turned up, but which we had come to regard as of great value. Can it be that the reward for finding them is so small as the Hewlett sale would lead us to suppose? If so, flint-collecting is certainly an appropriate hobby for a poor man of science.

Following closely on the announcement of the purchase by the Zoological Society of London of part of the Ashridge Estate as the site for a new Zoological Park, comes the news that Mr. G. B. Chapman, the well-known animal dealer, has purchased the "Withdean Hall" estate, on the London-Brighton Road, which he intends to form into a public zoological gardens. Considering the enormous interest which is taken in animals of all kinds in Great Britain, there is a notable lack of zoological gardens as compared with many other countries, there being only five in Great Britain, while in Germany there are more than twenty, and as many as ninety-two in the United States. Mr. Chapman's new gardens will be laid out on modern lines and the animals will be exhibited under the most natural conditions possible. Cages and bars will be to a great extent eliminated, and their place will be taken by wide ditches over which the animals cannot pass. Mr. Chapman is to be congratulated on his enterprise in providing for the public what will not only be a place of enjoyment and recreation, but also one of the highest educational value.

Prof. E. T. Whittaker delivered a lecture on "Present Conceptions of the Cosmos" at Bedford College for Women (University of London) on Mar. 22. Cosmology was founded, he said, in the fifth century B.C. by the Pythagoreans, who first put forward the idea that the earth was spherical; the difficulties they experienced in proving this statement are analogous to our difficulties in establishing present-day hypotheses concerning the size and nature of the whole universe of stars and space. Since the days of the Pythagoreans we have been convinced by experimental evidence that the earth is round and finite, so that there cannot be more than a maximum distance between two points on its surface. The methods of investigation, with the exception of the geodetic, depend on observations made outside the earth, but in considering the whole universe we have no external system of reference. We are apt to be misled by early education, which often implants *a priori* notions concerning space, and obscures the fact that the axioms on which Euclidean geometry is based are not necessarily true from all points of view. Systems of non-Euclidean geometry also have practical applications, and it is possible that on one of these systems as a basis, space may be found to be finite. The distinction between being finite and being unbounded must be clearly made. Space may very well be finite, yet with no boundaries; the traveller through space, unconscious that he is not moving in a straight line, may yet return eventually to his starting-point.

Since the Victorian age, Prof. Whittaker continued, the theory of relativity has produced a definite advance in the interpretation of the cosmos in terms of a non-Euclidean system. This theory helps to elucidate observations made on the astronomical universe. The number of stars, though immense, is not infinite, and their distance from the earth can be measured. The earth is situated in the Milky Way or galactic system, and the nearest star is at a distance of about four light years. The spiral nebulæ, first discovered by Lord Rosse in 1845, are the most distant objects yet observed and are right outside the galactic system; the latter has a diameter of roughly three-quarters of a million light years, while the spiral nebulæ are at a distance of from one to ten million light years. It has long been known that the motion of stars towards or away from the earth can be deduced from the shift of the spectral lines; a shift towards the red has been observed in the spectra of the spiral nebulæ, and it is therefore concluded that they are moving away from the earth. Einstein's theory of relativity, based on a non-Euclidean system, brings into account the possible curvature of the universe and predicts that a shift of the spectral lines towards the red will be observed for all bodies at a great distance. The diameter of the universe has been estimated from the spectral observations, and is found to be of the order of one hundred million light years. From this point of view, therefore, the universe, though remaining unbounded, may be said to be of a finite nature.

In his Friday evening discourse delivered at the Royal Institution on Mar. 25, Prof. C. T. R. Wilson stated that much may be learnt about the processes which are going on in a thundercloud by observing the sign and magnitude of the electric field which it produces at the surface of the earth and the sudden changes which lightning discharges cause in this field. These changes are generally of the order of 10,000 volts per metre below the central portion of the thundercloud, of the order of 1000 volts per metre at a distance of 10 kilometres, and they become comparable with the fine weather field of 100 volts per metre at about 20 kilometres. The fields destroyed by lightning discharges are most frequently negative below the thundercloud and positive at great distances. Thunderclouds seem to be essentially bipolar, with the positive charge above the negative. Discharge may occur between the upper and lower poles, between the ground and the lower or more rarely the upper pole, or between the upper pole and the upper atmosphere; combinations of these, either simultaneous or in rapid succession, also occur. From the magnitude of the sudden changes produced in the field by lightning discharges at known distances, the electric moments of the discharges (depending on the quantities discharged and their heights) may be determined. These generally exceed 30 coulomb-kilometres. The quantity discharged in a lightning flash is of the order of 20 coulombs. The potential difference developed in the cloud before discharge is of the order of one million kilovolts, and the energy spent in a lightning discharge is about 10^{17} ergs or 10^{10} joules. Nearly 2000 thunderstorms are on an average in action at a given time, and they may, perhaps, be the main sources of the downward current and positive potential gradient of fine weather regions. In a thundercloud, on account of the great distance through which the intense electric fields extend, effects may be possible which we cannot hope to produce in the laboratory. It may, for example, be possible for electrons to be accelerated until their energy is some hundreds of times as great as that of any known β-particle.

BY electing Dr. H. H. Woollard, at present assistant professor of anatomy and sub-dean of the Faculty of Medical Sciences at University College, London, to the chair of anatomy just vacated by Prof. Wood Jones, the University of Adelaide has once more deprived England of one of her best anatomists, who can ill be spared. Dr. Woollard obtained his M.D. in the University of Melbourne and served throughout the War in the Australian Medical Corps at Gallipoli and in France, eventually attaining the rank of Lieut.-Colonel and being awarded the Croix de Guerre avec Pâlme. After the War he joined the postgraduate class of anatomy at University College, London, and was invited to join the staff of the Department. He spent the academic year 1921–22 at Johns Hopkins University as a Rockefeller Foundation Fellow, and on his return to University College was made assistant professor. In addition to a monograph on the anatomy of Tarsius, in the main corroborating and extending the pioneer work of Burmeister, he has made exact histological surveys of the cerebral cortex of Tarsius and Orycteropus, and a detailed comparative study of the visual apparatus (retinal and cerebral) in the primates, yielding results of far-reaching value and importance for the student of human evolution. But perhaps his most distinctive achievements are his researches (in particular his application of the methylene-blue technique) on the double innervation of the heart, blood vessels, and striated muscles.

THE Prime Minister's appeal, issued by the Royal Society of Arts, for funds to ensure the preservation of ancient cottages throughout Great Britain, is one which should secure the hearty support of all lovers of beauty, as well as of those who appreciate the fact that these fast-vanishing relics of a bygone day have a value greater than the mere charm of their antiquity to those who seek to interpret the social and economic history of England in the past. Scarcely any material evidence which has survived from those earlier days can serve equally to throw light upon the conditions of agriculture, of rural industry, and of the labourer during the last two to three hundred years or more. Mr. Baldwin's appeal is supported by Mr. Thomas Hardy whose long and intimate acquaintance with rural conditions lends weight to his contention that the ancient type of mud-built cottage is superior to the modern brick structure, not merely on the ground of æsthetic considerations, but also in comfort. The appeal briefly outlines a scheme whereby the fund will endeavour to assist owners financially in securing fitting attention for these ancient cottages and the machinery by which an advisory council will work under the council of the Royal Society of Arts. Donations should be sent to the Secretary, Royal Society of Arts, John St., Adelphi, W.C.2.

THE centenary of the death of Ernst Florens Friedrich Chladni, who has often been called the father of modern acoustics, occurs on April 3. Chladni was born in Wittemberg on Nov. 30, 1756, and died at Breslau on April 3, 1827. His father was professor of law at Wittemberg, and it was in accordance with his wishes that Chladni also studied law. His natural inclination, however, was towards science, and he once wrote: "As an admirer of music, the elements of which I had begun to learn rather late, that is, in my nineteenth year, I noticed that the science of acoustics was more neglected than most other portions of physics. This excited in me the desire to make good the defect, and by new discovery to render some service to this part of science." He then goes on to show how he initiated the experiments on plates set in vibration in various ways. Taking a hint from the work of Lichtenberg of Gottingen, who had sprinkled fine powders on electrified planes, Chladni obtained those beautiful patterns which are given in most text-books. He next invented two new instruments, the euphone and the clavicylinder, and he spent a good deal of his time travelling and explaining his discoveries. Some of the experiments of Chladni were made known in a book published at Leipzig in 1787, but his fame is mainly due to his "Die Akustik" of 1802. When he visited Paris in 1808, Chladni had an opportunity of explaining his discoveries to Napoleon, who asked the Institute to report on them, and allocated 6000 francs for the translation of the work of Chladni into French. Chladni is also remembered for his views on meteors. His portrait forms the frontispiece of Tyndall's book on "Sound."

AMONG the most active of the scientific bodies of the south-west of England is the Royal Cornwall Polytechnic Society, which has recently issued its ninety-third annual report. Though like similar societies it has its lectures and papers, the Polytechnic Society also maintains a Meteorological Observatory and encourages both art and science in the county by holding exhibitions and awarding prizes, medals, and certificates. The exhibition is held at the same time as the summer meeting, and is supported by the Education Committee of the County Council. The present president of the Society is Viscount Falmouth, and the report contains his address in 1925 on the "Development of Physical Science," in which he traced the work of Rontgen, von Laue, Bragg, Rutherford, and others. Two papers reported in full are those on "The Mining Coinage of Cornwall," by Mr. Newton, and "Boulton and Watt in Cornwall," by Mr. Hamilton Jenkin. Towards the end of the eighteenth century there were more than 400 mines in Cornwall, and from these, practically all the copper used in England was obtained. It was the shortage of government coinage which led to the use of local coins and tokens, and it is of interest to note that many of these coins were made in Birmingham by Boulton and Watt, who were then busily engaged installing their engines in the mines. The Polytechnic Society possesses a large number of letters of Boulton and Watt, and Mr. Jenkin's paper was based on these. Boulton and Watt met with great opposition in Cornwall, and the troubles drove Watt to distraction. Boulton's instructions to their representatives in Cornwall when carrying out a steam trial are probably unique, for they begin: "Give a drink to all necessary persons and knock any man down that touches the coal or the fire during the whole trial," and ends with "We pray God send you a good deliverance."

His Majesty the King has approved the award of the Royal Medals of the Royal Geographical Society for 1927 as follows: *Founder's Medal*: to Major Kenneth Mason (Survey of India) for his connexion between the surveys of India and Russian Turkestan through the Pamirs in 1913 and his organisation and conduct of the Shaksgam Expedition of 1926; *Patron's Medal*: to Dr. Lauge Koch (Copenhagen) for his remarkable six years' exploration of northern Greenland. The Council has made the following awards: *Victoria Medal*: to Col. Sir Charles Close for his distinguished contributions to the advancement of the science of geography; *Murchison Grant*: to Mr. John Mathieson for his surveys of Spitsbergen and for his special studies during his long service with the Ordnance Survey in Scotland; *Back Grant*: to Capt. A. H. MacCarthy for his preparation and leadership of the ascent of Mount Logan, 1925; *Cuthbert Peek Grant*: to Mr. Francis Rodd to assist him in further exploration of the Sahara; *Gill Memorial*: to Mr. A. E. Young for his development of the mathematical theory of map projections.

At the annual general meeting of the Chemical Society held on Mar. 24, Prof. H. B. Dixon, Prof. G. G. Henderson, and Prof. A. Smithells were elected new vice-presidents, and Mr. M. P. Applebey, Mr. E. R. Bolton, Prof. J. E. Coates, Prof. J. C. Drummond, Dr. E. K. Rideal, and Prof. J. F. Spencer as new ordinary members of council. Prof. H. B. Baker delivered his presidential address entitled "Experiments on Molecular Complexity," which will appear in the *Journal of the Chemical Society* for April. The anniversary dinner took place the same evening at the Hotel Victoria. The toast of the Society was proposed by Viscount Sumner, while the toast of the guests, proposed by Sir William Pope, was responded to by Sir Ernest Rutherford, Prof. C. Matignon, representing the Société Chimique de France, and Prof. Wilhelm Schlenk, president of the Deutsche Chemische Gesellschaft.

The next meeting of the International Astronomical Union will be held at Leyden, Holland, commencing on July 5, 1928.

The council of the Geological Society of London has this year awarded the proceeds of the Daniel-Pidgeon Trust Fund to Mr. William Elgin Swinton, who proposes to undertake the comparison of British Mesozoic Reptilia with those from similar deposits on the continent of Europe.

On Feb. 24 a dinner was given in honour of Dr. A. P. Coleman, professor emeritus of geology, University of Toronto. It was arranged by some of his colleagues, former students, and other friends, and it was the occasion of the presentation to the University of Toronto of a portrait of Prof. Coleman, and also of a fund for the maintenance of a gold medal to be known as the Coleman Medal. This medal is to be awarded annually to the student who has obtained, at the time of graduation, the highest standing in his class in geology and mineralogy.

Mr. Henry Thomas Tizard, Principal Assistant Secretary, Department of Scientific and Industrial Research, has been appointed by His Majesty the King in Council to be Secretary to the Committee of the Privy Council for Scientific and Industrial Research on the retirement of Sir H. Frank Heath from that office on June 1 next.

Mrs. Bateson, widow of the late Dr. W. Bateson, Director of the John Innes Horticultural Institution, Merton, would be glad of the loan of letters written by Dr. Bateson to any readers of Nature. The letters would be copied and returned without delay unless copies themselves are sent. We are sure that any readers who possess such letters will be glad to assist Mrs. Bateson to bring together correspondence of personal or scientific interest carried on with Dr. Bateson. Communications should be addressed to her at 25 Bolton Gardens, London, S.W. 5.

The National Research Council of the United States recently granted authority for the establishment of a general committee on the physics of the earth. A number of subsidiary committees have already been elected to deal with such topics as the figure of the earth; seismology; terrestrial magnetism; the age of the earth; the internal constitution of the earth; meteorology; oceanography; and volcanology. The committees are largely American in constitution, but several British scientific workers have been included. Dr. Alfred Harker (Cambridge) has been invited to join the sub-committee on volcanology; Prof. Arthur Holmes (Durham) that on the age of the earth; and Dr. Harold Jeffreys (Cambridge) that on the internal constitution of the earth. The results of the work of the various committees will be published in the Bulletins of the National Research Council.

Exeter has been chosen this year as the centre for the meeting at Easter for regional survey study usually organised by Leplay House. The choice has been determined by the fact that Leplay House and the University College of the South-West at Exeter are co-operating in a regional survey of the south-west of England which, it is hoped, may have a considerable practical effect on the future development of this part of the country. An attractive scheme of study has been planned to cover the period April 14-23, which will include, in addition to the usual lectures and opportunities for individual study, visits to Dartmoor, Crediton, Topsham, and possibly Teignmouth, Dartmouth, and Brixham, thus covering a variety of types of geographical, economic, and industrial conditions in the area. Arrangements are also being made for a summer meeting at Warwick on Sept. 7-17. Particulars of membership, etc., may be obtained from the Secretary, Leplay House, 65 Belgrave Rd., S.W.1.

The council of the Institution of Mining and Metallurgy has made the following awards: The Gold Medal of the Institution to Prof. William Frecheville, in recognition of his services to the mining industry during a long and distinguished professional career, and to mining engineering education; The Consolidated Gold Fields of South Africa, Ltd., Gold Medal and Premium to Dr. Sydney W. Smith, for his paper, embodying much original research, on "Liquation in Molten Alloys and its possible Geological Significance"; and the Arthur Claudet Students' Prize to Mr. Robert A. Mackay for a paper on "The Influence of Superimposed Strata on the Deposition of Certain Lead-Zinc Ores."

The Report of the Secretary of the Smithsonian Institution, submitted on Dec. 9 last, records the acquisition of the Dognin collection of Lepidoptera, by means of gifts from friends amounting to 50,000 dollars. The collection contains 82,000 specimens, of which 3000 are types mostly from the New World, and will thus, it is claimed, give the United States National Museum a better representation of American species in this group than exists in any other museum. In the same report Dr. Walcott states that during the year the Smithsonian Institution directed or took part in forty scientific expeditions to various parts of the world. Most of these expeditions were for the collection of natural history specimens, and the report emphasises the urgent need for making such collections before more species of animals and plants are extinguished by the rapid encroachments of civilised man. This great activity was rendered possible by the generosity of other organisations and of many private citizens.

Applications are invited for the following appointments, on or before the dates mentioned:—A male assistant horticultural instructor at the Hertfordshire Agricultural Institute, Oaklands, St. Albans—The Clerk of the County Council, 28 Castle Street, Hertford (April 14). A head of the department of pharmacy of the Bradford Technical College—The Principal, Technical College, Bradford (April 23). A lecturer in geography (man or woman) at Bedford College for Women—The Secretary, Bedford College for Women, Regent's Park, N.W.1 (May 14). A teacher of woodwork and metal work at St. Olave's School, Tower Bridge, S.E.1—The Head Master. A sanitary inspector in connexion with the Sudan Medical Service—The Controller, Sudan Government, London Office, Wellington House, Buckingham Gate, S.W.1. Civilian education officers of the Royal Air Force—The Secretary, Air Ministry, Adastral House, Kingsway, W.C.2.

Our Astronomical Column.

Comets.—A later orbit of Stearns's comet, including observations up to Mar. 18, has been computed by Messrs. J. P. Möller and Bengt Strömgren (*Copenhagen Circ.* 144).

$$\begin{aligned} T &= 1927 \text{ Mar. } 1{\cdot}5645 \text{ U.T.} \\ &\left.\begin{aligned} \omega &= 6^\circ\ 57'{\cdot}64 \\ \Omega &= 214\ \ 31{\cdot}64 \\ i &= 87\ \ 8{\cdot}15 \end{aligned}\right\} 1927{\cdot}0 \\ \log q &= 0{\cdot}56575. \end{aligned}$$

The plane of the orbit agrees well with that found by Mr. L. E. Cunningham, but the date of perihelion is six months earlier, so that no increase in light is to be expected. The comet is, however, an easy telescopic object, and should be followed for several months. The following observation was obtained by Dr. A. C. D. Crommelin:

	R.A. 1927·0	S. Decl.
Mar. $27^d\ 0^h\ 48^m\ 39^s$ U.T.	$15^h\ 9^m\ 22^s{\cdot}40$	$1^\circ\ 43'\ 33''{\cdot}2$

The comet was about 1′ in diameter, with distinct central condensation; the position is in good agreement with that calculated from the above orbit, which is probably near the truth. The following are the positions for 0^h calculated from it:

April 5, R.A. $15^h\ 3^m\ 32^s$; N. Decl. 1° 36′; April 13, R.A. $14^h\ 57^m\ 12^s$; N. Decl. 4° 38′.

Mr. G. Merton has found an image of Pons-Winnecke's comet on a plate taken Feb. 25·06804 U.T. R.A. 1927·0, $14^h\ 4^m\ 25^s{\cdot}54$; N. Decl. 23° 49′ 13″·6; magnitude, 15; diameter, 15″. He has also measured a photograph of comet Comas Sola taken by Mr. F. J. Hargreaves and gives the following position:

Mar. 23·8729 U.T.; R.A. 1927·0, $4^h\ 36^m\ 26^s{\cdot}67$; N. Decl. 30° 27′ 43″·5; magnitude, 12·6.

Mercury as an Evening Star.—Herr C. Schoch writes to say that he had many replies to his request for observations of Mercury as an evening star in February (Nature, Feb. 12, p. 252). At Arosa, in Switzerland, it was visible for the first time on Feb. 13, the *arcus visionis* being 10°·2, the same as the value indicated by the old Babylonian observations. The duration of visibility was 62 minutes at Arosa, 66 minutes at Steglitz, the longest duration recorded at Babylon being 72 minutes. He noted the colour of Mercury, seen from Steglitz, as yellow, without admixture of red. Only three reports were received from England, the weather being generally cloudy.

Herr Schoch's latest value of the solar acceleration in a century is 2″·98 if measured by the increase of speed, but 1″·49 if measured by the distance gained, which is the more usual method. He ascribes the acceleration to the lengthening of the day by tidal friction, and gives the formula, length of day = 24^h (reckoned as in 1900) + $0^s{\cdot}00194T$, so that 52,000 years from 1900 will be required to make the day 1 second longer. T denotes the centuries after 1900.

Southern Double Stars.—Mr. W. H. van den Bos, who is observing southern double stars, gives a third list in *Bull. Astron. Instit. Netherlands*, 3, 114, containing 423 new pairs and bringing his total discoveries to 634, of which 50 are nearer than 0·24″, 104 between 0·25″ and 0·54″, and 87 between 0·55″ and 1·04″. Very few are of types *B* and *M*. More than one-third are of type *G*, the order then being *A*, *K*, *F*. ψ Sagittarii is an interesting star. The magnitudes are 5·5, 6·0, separation 0 2″, spectrum *F*5. This has also been observed as a spectroscopic double at the Lick Observatory station at Santiago; both spectra visible, relative velocity 130 km./sec. Mr. van den Bos says "This can hardly relate to the visual pair, unless the eccentricity and inclination are large, the period short, and the spectrograms taken near the node."

Research Items.

Orientation of Churches.—In a lecture on "The Orientation of Churches," recently delivered to the members of the Sidmouth Literary Society, the Rev. John Griffith paid a whole-hearted tribute to the work of Sir Norman Lockyer in the study of stone circles from the astronomical point of view. His attention was first directed to the subject by an article by Sir Norman on "The Agricultural Divisions of the Year" in NATURE, in which it was pointed out that the orientations of stone circles grouped themselves around February, May, August, and November. This 'farmer's year' was based upon a division of the year with which he himself had been familiar from boyhood and, as he had at once pointed out to Sir Norman, coincided with the Celtic divisions of the year of tradition and folklore; while English fairs, as dated at the beginning of the last century, clustered around these four points. These facts indicate a continuous calendrical usage from the present day back to the stone age, over a period of 4000 years. Stimulated by this result of the application of astronomical methods to the study of ancient monuments, Mr. Griffith has devoted himself to investigating the orientation of the older churches of Great Britain and has obtained similar results. He finds that, allowing for a difference of five days in the calendar between the twelfth century, when most of those churches were built, and the present day, there appears to be evidence of dedication to a popular saint, who often differs from the official patron saint. In Wales the choice is generally limited to four saints, Mary, Michael, Peter, and John the Baptist, while everywhere the feast of St. James with St. Philip on Mayday is popular as occupying a seat which, since the dawn of traditional history, has been held by one pagan deity or another.

Rest Periods in New Guinea.—In *Man* for March, Prof C. G. Seligman describes the alternation of rest and work periods among the Sinaugolo of Rigo District, New Guinea. Among this people the *dubu* could be built and the great feast, the *tabu*, be celebrated only during the *kaba* period; while in the period known as *dauka*, intervening between two *tabu* feasts, the drum was not sounded or the customary small feasts held, while only those known as *dauka*, feasts accompanying payment for a wife, and death and mourning feasts, could take place, dancing being to the accompaniment of bamboo dancing sticks and not the drum. Food was not piled on the *dubu* but on temporary platforms. Otherwise life proceeded as usual, and the customary hunting, fishing, planting, and sexual taboos were observed. A *dauka* period recurred every second or third year. According to the explanation of a Sinaugolo headman, these periods were instituted to secure the proper observation of these ceremonies, and a relaxation from the toil of ordinary life represented by the *dauka* period. In the *tabu* feast itself all neighbouring and friendly villages take part, but it is given by one portion of a village or by a clan, though sometimes two clans united for the purpose The preparations involved the collection of stores of food under a taboo. Food for the first ceremony, the *kidua*, is collected from neighbouring villages, this virtually constituting an invitation and acceptance of an invitation to the feast. This food was distributed to the visitors from neighbouring villages in the *kidua* ceremony. On the next day the pigs given at the *baiseno*, a dance preceding the *tabu* feast by about a month, were hung to the *dubu*. Then follows the giving away of the *tabu*, an essential feature of which was the boasting of the men with the object of instigating visitors to undertake the next *tabu*. For the next two or three days feasting follows, in which the pigs given at the *baiseno* are killed and eaten.

Early Chinese Cartography.—The oldest two maps of China known to exist were found some years ago at Hsianfu, the capital of the Shensi province, and were described by Prof. E. Chavannes in 1903. These maps formed the subject of a lecture by Prof. W. E. Soothill to the Royal Geographical Society on Mar. 14. They are engraved on stone, and preserved among other stone tablets. Chavannes dated the earlier of these maps 1043, but it is less easy to decide the date of the map from which much of it was copied. Prof. Soothill's conclusion is that the larger map is part of Chia Tan's map completed in A.D. 801, and that it may have been based on P'ei Hsiu's maps of the third century, not directly, but rather on copies elaborated by local cartographers. He believes that, with some change in names, it may be taken to represent China as it was known in the eighth century. The second map would appear to be more recent. It lacks the marginal notes of the other, and is covered by a grid of 100 li squares. Prof. Soothill thinks that it was drawn by an unknown cartographer some time during the three centuries preceding A.D. 1100, that is, after the time of Chia Tan. It suggests an endeavour to reconstruct P'ei Hsiu's lost map, using his net system, but it shows an advance in accuracy from Chia Tan's time.

Eskimo in East Greenland.—In a lecture to the Royal Geographical Society on Mar. 21 on the Cambridge expedition which he led to East Greenland last summer, Mr. J. M. Wordie referred to the traces of former Eskimo habitation which occur on that coast. A search of the coast region between Sabine Island and Scoresby Sound revealed a number of tent rings, groups of winter huts, and a few graves. Clavering Island is rich in remains: some regions, on the other hand, showed no traces. The conclusion is that the Eskimo can never have been very numerous on the east coast, and Mr. Wordie believes that the evidence points to only one period of immigration during which the Eskimo arrived by the north of Greenland. This is a reversion to the earlier views of H. P. Steensby, who held that the Eskimo followed the musk-ox by that route. Recent examination of the north coast of Greenland by K. Rasmussen renders that route unlikely, not merely in the lack of Eskimo remains but in the absence of game or possible hunting grounds and the bad travelling conditions. Mr. Wordie visited the new Eskimo settlements formed by the Danish Government on Scoresby Sound, which are composed of Eskimo of pure stock from Angmagsalik, the one surviving Eskimo settlement from the original colonisation of that coast. If game resources last, the prospects of these new colonies are good, but it must be remembered that the disappearance of the majority of the east-coast Eskimo during the nineteenth century was probably due to the exhaustion of resources. The same might occur again.

Fishery Investigations at Cullercoats.—The results of the investigations carried out at the Dove Marine Laboratory, Cullercoats, during the year ending June 30, 1926, are given in Report 15 (N.S.), which has recently been issued by the Laboratory. Mr. Storrow and Mrs. Cowan deal with their observations of the length, age, growth, and sexual condition of some 4600 herrings from commercial landings from the Shetlands, Firth of Forth, East Anglia, north-west and south of Ireland. Irish Sea, and Clyde. Mr. Gill, biochemist at the laboratory, gives a preliminary description of some investigations regarding the characterisation of the flesh protein of the herring, the subject being attacked from the point of view of the amino-acids present. Mr. Gill also reports on his estimations of the quantity of dissolved oxygen in the waters of the River Tyne. The percentage in the tidal region follows very closely the amount of fresh water coming down the river, both being at a maximum in the winter and at a minimum in the summer. Heavy rains, however, even for a few days, can raise the oxygen content of the estuary from its low summer values to the high winter values. Mrs. Cowan describes the growth under aquarium conditions of the lumpsucker (*Cyclopterus lumpus*) reared from the egg. Prof. Meek deals with some interesting replies to a letter circulated among fishermen and fishery officers requesting their opinions on the currents along the east coast of Great Britain.

VARIATION IN EARWIGS.—The bimodality of the curve for forceps-length in male earwigs (Forficula) has been well known since the original observations of Bateson and Brindley in 1892. Diakonov in 1925 published further evidence, from material collected in Russia, that the forceps are dimorphic and that the difference is probably not a genetic one but represents two independent positions of equilibrium for forceps development. He also showed various relationships between forceps-length and body-size, but the data were not fully analysed. Prof. J. S. Huxley (*Jour. of Genetics*, vol. 17, No 3) has now published the original measurements and added a further analysis of this apparently unique type of dimorphism. He finds that plotting the logarithm of forceps-length against the logarithm of body-length gives a straight line, indicating that this organ has the same growth-mechanism as other organs showing heterogonic growth With increasing body-size there is a tendency for the forceps to shift from short to long, the forceps of the largest animals always coming in the long group. In a colony under unfavourable conditions there was a decrease of mean body-size, but the means of forceps-length were scarcely affected. Nevertheless, the percentage of individuals in the population with short forceps was considerably increased. Similarly, more favourable conditions shift the forceps-length of some individuals during their development from the short to the long type. But there is still no evidence as to why there should be two positions of stability in forceps-length with a gap between them. This can probably only be determined by experiment.

MICRO-ORGANISMS IN TICKS.—Part I. of the 11th and 12th Reports of the Director (Sir Arnold Theiler) of Veterinary Education and Research of the Union of South Africa (Pretoria, Sept. 1926, 817 pp.) contains twenty-six papers ranging over the varied work of this active Department—serological investigations and other studies on blood and on inoculation, protozoology, helminthology, entomology, and studies on grasses and other plants. Attention may be directed to the account, by Dr. E. V. Cowdry, of a group of micro-organisms transmitted hereditarily in ticks and apparently unassociated with disease. These organisms are pleomorphic, bacterium-like, and intracellular, and they stain much less intensely with ordinary methods than most bacteria. They were found in fifteen different species of ticks, including representatives of the Argasidæ as well as the Ixodidæ. No evidence could be found of injury to the tissues of the ticks other than physical distention of the cells to accommodate large numbers of the organisms. They were found in every tick examined, not only from South Africa but also from Jamaica, Trinidad, Honolulu, and several parts of the United States; and as they were present in the eggs of ten species and in the unfed larvæ of seven species, it was concluded that transmission was hereditary. The organisms in several respects resembled Rickettsia, but were of larger size. They also resembled the symbionts of certain lice and blood-feeding flies, but they never gave rise to definite organ-like structures comparable with the mycetomes, and they were restricted to the Malpighian tubes and the eggs, whereas the symbionts referred to are confined to the digestive tract.

THE UTILISATION OF POLLEN BY THE HONEYBEE.—In a paper entitled "The Collection and Utilisation of Pollen by the Honeybee," published as Memoir 98 (June 1926) of the Cornell University Agricultural Experiment Station, Mr. Ralph L. Parker contributes observations of considerable interest. Pollen is known to be the chief source of protein in the food of bees, and a lack of it reacts deleteriously upon the developing brood. The adult bees use the nitrogenous material of pollen in the elaboration of the brood food that is fed to the larvæ for the first two days after eclosion from the egg. This predigested food is fed to the queen all through her larval life. The worker and drone larvæ, on the other hand, are fed afterwards with a mixture of honey and undigested pollen. Substitutes for pollen such as rye, oats, corn, pea-meal, etc., were not found to be beneficial. The feeding with such substitutes is a failure, since, although it may stimulate egg-laying by the queen and brood-care by the workers, larval development is not completed. Some of the simple sugars and proteins of pollen are available to the bee, but most of the other contents are not available. Proteolytic enzymes have been shown to be present in the bee's alimentary canal, but the actual proteins of pollen utilised by that insect have not, so far, been identified. Bee-keepers in regions which at times experience a shortage of pollen during the beginning of the season, are advised to preserve combs of pollen for use during such an eventuality, since no efficient substitutes can be recommended.

ORE DRESSING IN CANADA.—The Annual Report of Investigations in Ore Dressing and Metallurgy for 1925 by the Mines Branch of the Canadian Department of Mines has just been published and shows evidence of very active work. A number of complex ores, *e.g.* silver-lead-zinc, gold-copper, copper-lead-zinc, etc., have been investigated, and satisfactory methods for the treatment of the ores have in most cases been devised. A new process is outlined for the treatment of ilmenite, producing a titanium oxide concentrate capable of being used for the production of pigment and other purposes. Detailed reports upon the concentration by flotation of Canadian molybdenite and graphite ores are also included. It is evident that this section of the Department of Mines is doing excellent service in the development of the Canadian mining industry.

THE PALAGONITE FORMATION OF ICELAND.—The first of a series of papers describing a comprehensive study of the Icelandic eruptives (based on a collection made in 1924 by Dr. G. W. Tyrrell and Dr. M. A. Peacock) appears in the *Trans. Roy. Soc Edin.*, vol. 55, Pt. 1, No. 3, 1926. It consists of a preface to the series, followed by an account of the basic tuffs by Dr. Peacock. These are either sideromelan-tuffs or palagonite-tuffs. The former consist of basalt glass which has been drastically chilled and fragmented owing to the sub-glacial extrusion of basalt magma. The palagonite-tuffs are the older sideromelan-tuffs which have been hydrated, usually by submersion beneath the sea or by hot springs. It is shown that palagonite is essentially the hydrogel of sideromelan, the hydration being accompanied by a partial loss of lime and soda and an almost complete oxidation of iron. The palagonite due to submersion is an isotropic yellow gel, but in that due to the action of hot springs there is an obscurely birefringent fibrous structure. Both types are unstable and tend to crystallise with loss of part of the water into chlorites and zeolites. It is suggested that Fermor's proposal to use the term *palagonite* for chlorophæite and other late-magmatic hydrous residual materials in basaltic rocks should be discontinued, since the latter, though of somewhat similar composition to that of the Iceland palagonite, have originated by an entirely different process.

The Composition of Meteorites.—In the *Proc. Amer. Phil. Soc.*, vol. 65, No. 2, p. 119, G. P. Merrill summarises recent work on the chemical and mineral composition of meteorites. The chief point of interest is the result of a series of carefully conducted analyses of representative masses. Twenty-eight terrestrial elements have so far been detected, among those not found being antimony, arsenic, barium, strontium, fluorine, lithium, tin, lead, zinc, and gold. This is a particularly significant list, for it includes many of the common ore- and gangue-making elements that are associated with the continental rocks of the earth. The characteristic ore-making elements of norites and peridotites, such as copper, cobalt, nickel, and the platinum group, are all present, as would be expected. The minerals of meteorites are in many cases of a type that can be accounted for, provided that oxygen was relatively deficient in the medium from which they crystallised. It is pointed out that nothing akin to rocks of the granite family has been found in meteorites; and further, that meteorites have never been found in terrestrial beds of any geological horizon but the most recent. Merrill regards the possible meteoric origin of tektites as still unproved.

Coal Carbonisation.—On Feb. 8, 1927, Dr. C. H. Lander, Director of the Fuel Research Board, read a paper before the Institution of Petroleum Technologists on "The Production of Oil from Coal." The history and work of the Fuel Research Department, which set out to study this problem in particular, was surveyed. The most interesting part was a disclosure of recent experience with vertical retorts of cast iron. Coal has been carbonised at 625° continuously in this retort setting, from March to December 1926, when it was let down for inspection. These retorts, which are again in use, are stated to have been easy to operate, and the coke product has given satisfaction to consumers. Yields of tar reaching 18 gal./ton were obtained, and it is believed that the retorts approach technical success More experience of protracted working is necessary before commercial success can be assessed.

Irregular Emission of X-Rays.—Any experimental work with X-rays in which unusual discontinuities are recorded is now of particular interest, in view of its possible bearing on the *J*-phenomena which are being investigated by Prof. Barkla and his school. It has already been shown that in certain circumstances the relation between the intensity of a number of characteristic rays and the voltage on the bulb changes abruptly at about 4·5 times the minimum potential required for the excitation of each. D. Nasledow and P. Scharawsky, working in the X-ray Institute at Kiew, now report similar changes when a Muller tube of the hot filament type is run at constant voltage and with a variable current (*Zeit. für Phys.*, **41**, p. 155, 1927). The $K\alpha$ and $K\beta$ lines from a copper target were separated by reflection from calcite, and their intensities were measured by an ionisation method. When less than 4 milliamperes were passing through the bulb, the intensity of either line was closely proportional to the current; for greater currents the rate of increase was linear, but less rapid than before. A break still took place at 4 milliamp., when the exciting peak voltage was raised from 30 kilovolts to 45 kilovolts. No explanation is offered of these results—which the authors propose to extend—but the apparatus appears to be described in sufficient detail to permit of comparison with the experience of other workers in this field.

Forms of Sulphur Trioxide.—The *Gazzetta Chimica Italiana* for Jan. 1927 contains a series of memoirs by G. Oddo and A. Casalino on the different forms of sulphur trioxide, which were studied some years ago by Oddo. The vapour density of the liquid form at 25° is only slightly above the value for SO_3, although slight association may be present. The amorphous and fibrous solid varieties gave molecular weights about 83·77 as a mean. The solutions of the trioxide in phosphoryl chloride were found to give solid solutions in all proportions, and the results of the depression of freezing-point were therefore irregular and unsuitable for the determination of the molecular weight. In anhydrous sulphuric acid the molecular weight of the liquid form was 80, of the fibrous form 88. The papers contain a detailed description of the preparation of the different forms of sulphur trioxide and of the transformation of one form into another.

Magnetic Observations in Australia.—Magnetic observatories in the southern hemisphere are so few that it is an event of some importance when a new one is instituted. For many years, only one magnetic observatory was in operation in Australia, at Melbourne, and even this was of limited service to magnetic science owing to the non-publication of its observations. Gradually this observatory became disturbed by electric tramways, and in 1919 a new observatory, 34 miles away, was built. The magnetograph house is above ground, and consists of a chamber within a chamber, the walls being well lagged to reduce temperature changes. No attempt is made to control the temperature of the inner room by artificial heating. There is no resident observer, the records being changed by a local resident, who also registers a time-break at the beginning and end of each record. The records are posted weekly to Melbourne for development and computation; an observatory official visits the station monthly to make absolute observations for base-line values, and to execute any necessary adjustments. The magnetographs are of the Eschenhagen type; the absolute instruments include a Kew magnetometer and a Schultz earth inductor. During 1924, which appears to be the first year for which hourly observations are published, the vertical force instrument gave considerable trouble, there being large changes in scale value and base line; the horizontal force magnetograph had a nearly constant scale value. The results are given in an (undated) publication, "Melbourne Observatory: Hourly values of the magnetic elements at Toolangi in 1924." It is very satisfactory that the Director, Dr. J. M. Baldwin, has been able both to institute this new observatory and also to obtain publication of hourly values of the elements, a course which places the observations so fully at the disposal of investigators of terrestrial magnetism. It is to be hoped that in time the Government of Victoria may provide the funds necessary for a resident observer, without which it is impossible to maintain a magnetic observatory with full efficiency. The only other magnetic observatory in Australia is the one recently instituted by the Department of Terrestrial Magnetism of the Carnegie Institution of Washington; it is situated near Perth, Western Australia.

The Botany School of the University of Sydney.

THE opening of the new Botany School in the University of Sydney is an event not only important for the British Empire, but also for the world at large. The building is in modernised perpendicular Gothic and harmonises with the main structure of the University of Sydney, which presents some interesting resemblances both in its architecture and its origin to the well-known main building of the University of Toronto. The construction is in stone, and the building is so arranged that it will be an ornament to the University for many years. Although architecturally attractive, it does not represent the petrification of the science in the Pierian springs of architecture rightly dreaded by Thomas Huxley, for it is thoroughly well lighted, spacious, and in every way practical. The entrance is adorned by representations of some of the great masters in the science. The idea of commemorating the great, however, is not confined to the exterior of the building, for the laboratories and other work-rooms are named after distinguished botanists. The botanical museum bears the names of Bentham and Hooker, and its windows show the portraits of such outstanding botanists as Hofmeister, Grew, Sachs, Nageli, Hooker, Bentham, and others. The herbarium, which is spacious and well equipped, is named after John Ray, and in its windows appear effigies of Morrison, Ray, Tournefort, De Jussieu, Linnæus, Robert Brown, etc. The advanced laboratory is named after Charles Darwin. The research laboratory bears the name of Robert Brown, while the first-year laboratory is named after Sir Joseph Banks, two names so signally connected with the beginnings of Australian botany.

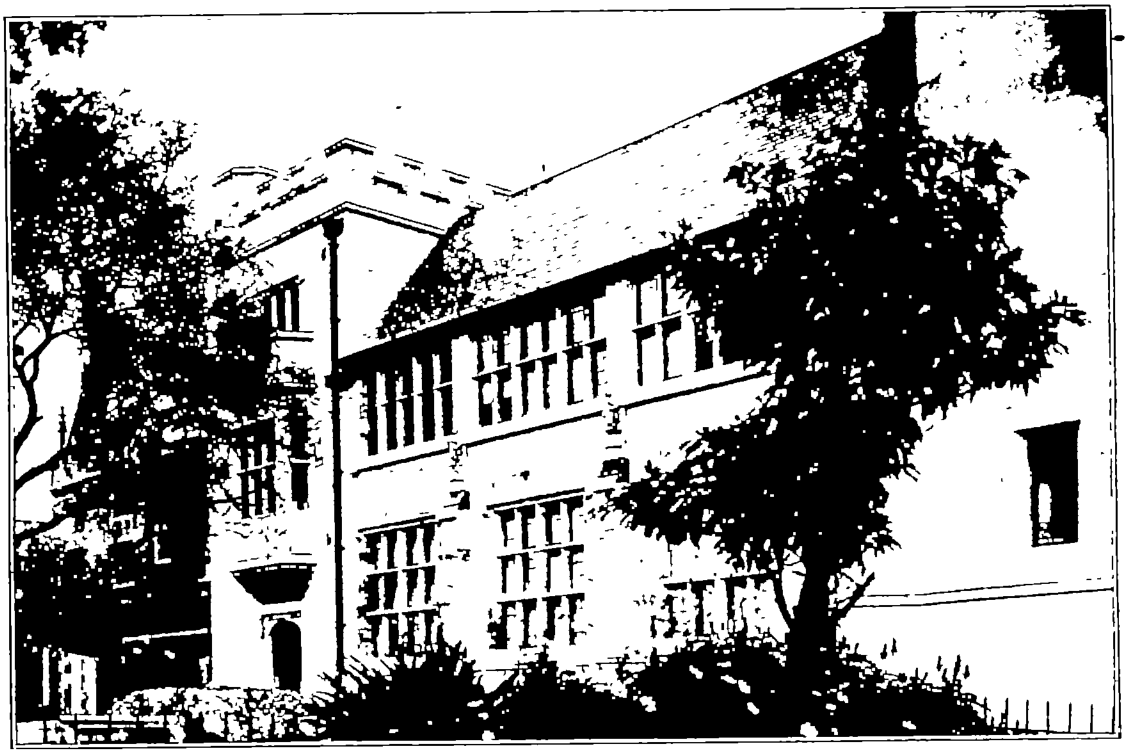

Fig. 1.—Botany School of the University of Sydney, N.S W.

The library and reading-rooms provide abundance of space, but the shelves are as yet meagrely lined with books. It is hoped that this shortcoming may, before long, be remedied in view of the great interest which the public in Sydney has begun to take in botanical science.

A physiological laboratory is also among the rooms in the Botany School, and it supplies excellent facilities for the prosecution of that important side of the science. Numerous research rooms for the staff and advanced students are included in the plan of the building, and last, but not least, the lecture theatre is capable of seating two hundred students.

The building was formally opened on Nov. 6, 1926, in the presence of the Governor of New South Wales, the Vice-Chancellor of the University, and Prof. Anstruther Lawson, the head of the school. Prof. E. C. Jeffrey, of Harvard University, was present as guest of honour to deliver an address and also the formal felicitations of this University.

The opening of the new Botany School in Sydney University is a scientific event of the first magnitude, because it supplies an equipment in the southern hemisphere in every way adequate for the carrying on of botanical investigation. The facilities provided by the Botany School, in fact, compare most favourably with those which are offered by the larger universities in the northern hemisphere. In his remarks Prof. Jeffrey referred to the great advantages which Australasia presents to the students of plants, combining as it does a great variety of environment with healthful conditions of existence and a stable and well-organised government. Australasia, in fact, unites to a large extent the advantages of the tropics with the comfort and salubrity of temperate regions. The flora of Australia is quite as interesting as its fauna, but not nearly so well known. It was suggested, further, that it would be a great advantage if every student of botany in the northern hemisphere could some time or other visit Australasia. Prof Lawson, in the name of the University, offered the full hospitality of the botanical laboratory to visiting botanists.

The Botany School of the University of Sydney is a monument to the zeal, capacity, and artistic sense of Prof. Anstruther Lawson. The school has already a large and growing body of students and a highly creditable list of published researches.

E C. J.

Animal Breeding Research Department, University of Edinburgh.

We have received from the Director, Dr. F. A. E. Crew, the sixth annual report of the Animal Breeding Research Department of the University of Edinburgh. This department has recently received two large benefactions, namely, £10,000 from Lord Woolavington toward a fund for converting the directorship into a University chair, and £30,000 for general purposes from the Rockefeller Fund, so that the Department has the happy prospect of enlarging the scope of its work.

The report before us contains the list of a large number of problems of inheritance which are being attacked, but the progress made with the solution of any of them seems to be but moderate. 'All of them will require a long stretch of years before any considerable advance is made towards their solution, and in the case of domestic animals, the numbers with which it is possible to deal are too small to justify a successful analysis into Mendelian 'factors.'

More striking results are obtained from the investigation of endocrine reactions. We may direct attention to some extremely interesting results of extirpation of gonads in the mouse obtained by Mr. Kasur. The weight of the male remains unchanged, that of the female increases, but the kidney of the normal male is much heavier than that of the normal female, whereas the thymus and spleen of the former are considerably lighter than those of the latter After castration the kidney of the male decreases whilst the thymus and spleen increase in weight, so that in all these respects the animal approaches the female type.

Another thought-provoking result was obtained by Mr. A. W. Greenwood acting in collaboration with the Director. He grafted into the body of a female chick four days old, after removing her ovaries, the testes of her brother. The bird assumed the plumage of the cock. This is in accordance with Zawadovsky's interesting results, in which he converted a cock into a hen and vice versa by the transposition of the gonads. But in the case under consideration the bird, after a subsequent moult, reverted to the plumage of the hen. A post-mortem examination revealed the fact that a small fragment of the functional left ovary had been left in the body by the operation, but that this remnant had degenerated. Not only, however, had the testis grafts survived and produced an abundance of testicular tissue, but ovariotomy had stimulated the vestigial right ovary to activity and it had also produced testicular tissue, so that the bird was in fact over-masculinised. Messrs. Greenwood and Crew advance the hypothesis that the ovary exercises a heavier drain on metabolism than the testis, and that the distinction between male and female secondary sexual characters is due to the degree of strain exercised on the organisation by the respective gonad in each case. If the testis is artificially increased in bulk beyond the normal, it exercises a strain equal to that of the ovary, and hence the secondary sexual characters of the female are produced.

E. W. M.

Experiments on Molecular Complexity.

Prof. H. Brereton Baker, for his presidential address at the annual general meeting of the Chemical Society on Mar. 24, chose as his theme "Experiments on Molecular Complexity." He had claimed that, like Sir Isaac Newton, "hypotheses non fingo," but, speaking later at the anniversary dinner, admitted that he was an inveterate maker of hypotheses, which, however, he forbore to publish.

The investigations described in the address arose out of the observation, some five years ago, that if liquids of very varying types were subjected to prolonged drying, the boiling points were raised to a very considerable extent. This rise, ascribed to an increase in the complexity of the molecules, takes place with typically unassociated liquids; hence it may be that all liquids are capable of association. Since water can also promote dissociation, it is conceivable that its absence might influence the molecular complexity in opposite directions; so far, however, dry liquids boiling at subnormal temperatures have not been obtained, although dry benzene has been separated into fractions boiling at 80° and 118° respectively. Further researches were carried out to see if catalysts other than water are effective, the experimental methods involving measurements of vapour density and surface tension.

Preliminary experiments in barometer tubes with very pure sugar charcoal gave definitely positive, although not quantitatively reproducible, results. For example, the vapour pressure of ethyl ether at 16° was raised by 25 mm., of methyl alcohol at 35° by 12 mm., and of benzene at 23° or 37° by 2 mm. Prolonged experiments with Smith and Menzies' methods still gave variable results—a circumstance which has led Prof. Baker to two somewhat important deductions. First, a catalyst evidently acts very slowly, and sometimes in a direction contrary to that shown in the final equilibrium; secondly, a pure liquid appears to have no constancy of composition, but possesses a vapour pressure which depends on the history of the specimen. It therefore became necessary to employ a method by which the vapour pressure of the liquid could be balanced against that of the liquid with the catalyst.

Such a method made use of a U-tube containing mercury, the horizontal upper ends each carrying a pair of bulbs, and being connected by a capillary tube. The liquid could thus be distilled on to a catalyst, the capillary junction closed, and the difference arising between the vapour pressure of the pure liquid and that in contact with the catalyst could be directly measured. Acetic acid, benzene, methyl alcohol, ether, and bromine were examined, the catalysts being charcoal, platinum black, or thoria In every case the catalyst caused an increase in the vapour pressure of the liquid; such a difference was, indeed, clearly apparent in a sample tube exhibited. An even more striking exhibit was a two-limbed tube in which, three weeks previously, accurately measured equal volumes of bromine had been placed, one of the limbs also containing charcoal. After evacuation, the tube had been sealed; so much bromine had afterwards distilled from the limb containing the catalyst that the charcoal was left almost dry. A refinement of the barometer tube method showed that the difference was increased by heating and diminished by cooling; heating and afterwards cooling to 20° always caused an increase in vapour pressure, and cooling the reverse, the original value for a particular catalyst being restored only after some weeks.

For the surface tension measurements Ramsay and Shields' method was employed, the diameters of the specially resistant capillary tubes being determined directly to one-thousandth part of a millimetre. Comparison tubes were, of course, always used. It was noteworthy that the pure liquid, for example, acetic acid, does not reach its normal value until three weeks after filling the tube, the process of boiling to remove air clearly causing dissociation. Thus, after 2 days the molecular weight was 1·568 × 60, and after 3 weeks or 9 months, 2·097 × 60. Heating for a short period in most cases increased the molecular complexity, whilst heating for a long period decreased it. The catalyst, which gave a molecular weight value for acetic acid (measured after 3 weeks) of 2·525 × 60, did not immediately produce its maximum effect on the complexity of the molecules.

Prof. Baker considers that all liquids may be regarded as analogous to a dissociable gas such as nitrogen tetroxide, the processes of association and dissociation, however, being much slower for liquids than for gases. The effect of the presence of solid catalysts, as would be expected, is much slower for the liquid than for the gaseous condition, and it is difficult to understand how their special influence is exerted. The president acknowledged the help given to him by his assistant, Miss Margaret Carlton, who has done a considerable portion of the experimental work.

University and Educational Intelligence.

EDINBURGH.—Mr. V. Gordon Childe has been appointed by the University Court as the first occupant of the Abercromby chair of archæology. This chair was founded in 1925 in accordance with a provision for its endowment in the will of the late Lord Abercromby, the well-known archæologist and authority on the pottery of the bronze age in Britain. Mr. Childe was educated at the University of Sydney, where, after taking his M.A. degree, he was awarded a classical scholarship tenable at Oxford. He became a member of Queen's College, Oxford, in 1914, took his B.Litt. in 1916, and a first class in the honours school of *Literæ Humaniores* in 1917. After a short period spent in Australia, Mr. Childe returned to England, and since then has been engaged in archæological research and has acted as librarian of the Royal Anthropological Institute. He has published a number of papers in archæological periodicals and two books of great erudition and originality in the History of Civilisation Series—"The Dawn of European Civilisation" and "The Aryans."

LEEDS.—The Miners' Welfare Committee has offered a contribution of £10,000 towards the cost of erection of a new building for the Mining Department of the University. This shares with the Department of Coal Gas and Fuel Industries a building which was erected in 1906, but now, owing to the growth of both departments, it has become inadequate. The Department has received loyal support from the industry. Since 1899 the West Yorkshire Coal Owners' Association has made an annual grant, and has recently contributed £25,000 to the University Development Fund, while contributions from individual members of the mining industry amount to more than £2500. The support thus given by the industry may not improbably result in the Mining Department being the first part of the building scheme to be undertaken.

LONDON.—Mr. W. E. Le Gros Clark has been appointed as from Sept. 1 to the University chair of anatomy tenable at St. Bartholomew's Hospital Medical College. In 1924 Mr. Clark was awarded the Hunterian Medal for anatomical research, and was elected a member of the Board of Examiners for the Fellowship of the Royal College of Surgeons. He has published numerous contributions on the skulls of primates in the *Proceedings of the Zoological Society*, *Journal of Anatomy*, and similar publications.

Dr. Hamilton Hartridge has been appointed as from Sept. 1 to the University chair of physiology tenable at St. Bartholomew's Hospital Medical College. Dr. Hartridge has been a fellow of King's College, Cambridge, since 1912, and was awarded the Horton Smith Prize in 1918. Since 1919 he has been lecturer on organs of special sense and senior demonstrator in physiology at the Physiology Laboratories, Cambridge. He has published numerous papers in *Proceedings of the Royal Society*, 1922–25, *Philosophical Magazine*, 1923, and the *Proceedings of the Cambridge Philosophical Society*.

The following Doctorates have been conferred: D.Sc. in statistics on Mr. A. E. R. Church (University College), for a thesis entitled "On the Means and Squared Standard Deviations of small Samples from any Population"; D.Sc. in physics on Dr. R. C. Johnson, for a thesis entitled "The Structure and Origin of the Swan Band Spectrum of Carbon," and other papers.

OXFORD.—The Delegacy for Extra-Mural Studies has arranged a special course of zoology, primarily for teachers of science in secondary schools, on Aug. 2-12. The course, which is part of the annual summer meeting organised by the Delegacy, will deal mainly with recent developments in zoology. Further particulars and application forms can be obtained from the Rev. F. E. Hutchinson, Acland House, Broad Street, Oxford.

THE annual value of the Beit memorial fellowships for medical research has been increased and will take effect as from October 1 next. An election of junior fellows will take place in July next. Applications upon a prescribed form must be sent on or before June 1 to Sir James K. Fowler, Honorary Secretary, Beit Memorial Fellowships for Medical Research, 35 Clarges Street, W.1.

THE Air Council has decided to increase the number of prize cadetships in the Royal Air Force offered for competition annually from three to twelve. These cadetships enable boys to complete the two years' course at the R.A.F. Cadet College, Cranwell, at a cost of only £40 in all to their parents. Candidates are selected at an examination held by the Civil Service Commission in June and November; they must be between 17½ and 19½ years of age, and must be in possession of School Certificate A or B. Applications for the June examination must reach the Civil Service Commission on or before May 4. Further information can be obtained on application to the Secretary, Air Ministry, London. W.C.2.

THE list of "Students from other Countries in the Universities and University Colleges of Great Britain and Ireland in October 1926," issued by the Universities Bureau of the British Empire (50 Russell Square, London, W.C.1), contains more than its title suggests. It is a register of the names of students from other countries attending each institution of university rank, and may appear, therefore, to have either the virtues or vices of a public card-index according to the purpose or predilection of the person seeking the type of information afforded by a list of actual names. It is to be noted, however, that on one page the number of students from each country is set out. The following extracts from that page may not be without significance: Africa, 1054; America, 824; Asia, 1754; Europe, 643; The Pacific, 321.

Calendar of Discovery and Invention.

April 3, 1449.—In the Patent Roll, 27 Henry VI., Part 2, No. 468, is the grant of letters patent, dated April 3, 1449, to John of Utynam, born in Flanders, for the exclusive right of making coloured glass for twenty years. This is the earliest known example of an industrial monopoly patent in England or elsewhere. John came to England at the King's command to make glass for Eton College and St. Mary and St. Nicholas College, Cambridge, and because the said art had never been used in England and John intended to instruct divers lieges of the King in many other arts never used in the realm, the King granted that no liege of the King learned in such arts was to use them for a term of twenty years against the will and consent of John under a penalty of £200.

April 4, 1879.—During the course of his lectures at Birkbeck College, Chaloner remarked, "The man who eliminates phosphorus by means of the Bessemer converter will make his fortune." This chance remark fixed itself in the mind of Sidney Gilchrist Thomas, the police-court clerk, who after some years' experiments solved the problem, and in 1877 and 1878 took out patents for the manufacture of 'basic' steel. He was assisted by several metallurgists, but it was Windsor Richards who on April 4, 1879, made the first successful experiments on a large scale, these being carried out at the works of Bolckow, Vaughan, and Co., Middlesbrough. Thomas reaped a fortune, but died at the early age of thirty-five years and was buried in the Passy Cemetery, Paris.

April 5, 1864.—An important improvement in photography was announced by Swan in his paper on the new carbon process read to the Photographic Society on April 5, 1864. Swan employed a tissue "as pliant as paper, and as transparent and smooth as glass, formed of collodion on the one side, and of gelatine impregnated with ammonium bichromate, carbon (indian ink) and saccharine matter (sugar) on the other." Swan's process was at once adopted, notably in France, and to it we owe the finest reproductions of famous pictures.

April 6, 1911.—Leaving New York in the *Roosevelt* in July 1908, Peary again set out for the Arctic, and on April 6, 1911, reached the North Pole, "the crowning result of twenty-three years' devotion to Arctic exploration."

April 7, 1795.—Before the Revolution there was no uniformity in French weights and measures. On May 8, 1790, the Constituent Assembly therefore charged the Paris Academy of Sciences with the organisation of a better system. Lagrange, Laplace, Cassini, Mechain, Lavoisier, Delambre, Prony, and others took part in the work, but it was the measurement of an arc of the meridian from Dunkirk to Barcelona by Delambre and Mechain which led to the adoption of the metre—$\frac{1}{10,000,000}$th part of the distance from pole to equator—as the standard of length, this important unit being made legal on April 7, 1795. The whole metric system of weights and measures was completed in 1799, and was made the only legal one on Nov. 2, 1801.

April 8, 1838.—Regular trans-Atlantic steam navigation was inaugurated by the s.s. *Great Western*, which left Bristol for New York on April 8, 1838. She was a fine wooden paddle-wheel vessel, especially designed by Brunel for this traffic, and was the most remarkable ship of her day. Other steam vessels such as the *Savannah*, H.M.S. *Rhadamanthus*, *Curacoa*, and *Royal William* had crossed the Atlantic before, but were quite unsuitable for continuous steaming, while the first Cunarder, the *Britannia*, did not begin running until 1840. E. C. S.

Societies and Academies.

London.

Royal Society, Mar. 24.—**Sybil Cooper, D. E. Denny-Brown, and Sir Charles S. Sherrington**: Interaction between ipsilateral spinal reflexes acting on the flexor muscles of the hind-limb. The contraction evoked by reflexes exciting the same muscle when they are concurrent falls largely below the sum of the individual effects which they exert when apart. The effect of one of a pair of concurrent reflexes may default totally, *i.e.* be totally occluded. Such 'occluding' interaction is quite different from the inhibitory interaction of 'antagonistic' reflexes. Its explanation seems to be that, at some structure impinged upon in common by the 'allied' reflexes, (1) tetanic activation from one source precludes concurrent activation by a second, and (2) is not disturbed by the convergent activity of a second. The occlusion is a measure of the convergent overlap of 'allied' reflexes upon 'motor units' held in common. The occluded contraction emerges from occlusion without pause and step for step as the occluding activation subsides. Each individual afferent excites a reflex contraction which is of a pattern specific to that particular afferent.

R. J. Ludford: The Golgi apparatus in the cells of tissue cultures. The Golgi apparatus in the cells of tissue cultures undergoes a change in form with the spreading out of the cells on the surface of the cover-glass. It may be stretched until it fragments and its individual particles become dispersed in the cytoplasm; in other cells the osmophil substance of the Golgi apparatus becomes spread in the form of rodlets and granules upon a less deeply impregnated material (the idiosome, or sphere substance), and both substances become scattered together in the cytoplasm. Certain of the fatty globules in the cells of tissue cultures are considered to arise in relationship with the Golgi apparatus.

C. E. Walker and Margaret Allen: The nature of Golgi bodies and other cytoplasmic structures appearing in fixed material. If lecithin and kephalin are added to colloidal mixtures and films or drops fixed without using acetic acid, structures exactly resembling Golgi elements, etc., are produced. Mitochondria, etc., are also represented. These structures also do not appear if acetic acid is used in the fixative. These artificial structures behave in the same way as Golgi apparatus, etc., when treated with osmic acid and when washed with turpentine. On adding oleaginous emulsions to the colloidal mixtures the structures produced by fixation and osmication appear to behave in a similar manner in relation to the globules of the emulsion as do Golgi elements, etc., to the nucleus of the cell.

W. S. Patton and E. Hindle: The development of Chinese leishmania in *Phlebotomus major* var. *Chinensis* and *P. sergenti*, var. (See Nature, Mar. 26, p. 460.)

G. S. Sansom. The giant cells in the placenta of the rabbit. Two kinds of giant cells are found in the uterus. The larger are derived from the fœtal trophoblast. They rapidly attain an enormous size, persist until about the 22nd day, and then break up into smaller bodies. Large numbers of these cells are also formed from a portion of the trophoblast which projects free into the uterine cavity after the attachment of the blastocyst to the placental folds on the 8th day. The cells proliferated from this 'trophoblastic fringe' pass into the uterine cavity and penetrate the regenerated uterine epithelium. The mesometrial giant cells are of maternal origin. Appearing about the 11th day and persisting until after the 27th day, they never attain great size. The trophoblast of the chorion læve gives origin to great numbers of multinucleate spheres, which become free, and are inactive degenerate structures.

Linnean Society, Feb. 17.—Miss Eleanor **Vachell**: An unusual specimen of Anagallis. The plant was noticed in a newly constructed public park at Coldknap, Barry, Glamorgan, in July 1926. It had eleven stems—seven bearing scarlet flowers and four bearing blue flowers. Two types, *A. arvensis* Linn. and *A. fœmina* Mill., are apparently represented on the same plant.—Julian S. **Huxley**: On the relation between egg-weight and body-weight in birds. The lysis of Heinroth's data on the body-weight and eight of 432 species of birds reveals certain s not brought out in his paper. For birds as a , the relative egg-weight decreases from 12·2 3 per cent. of body-weight as we pass from the of lowest to that of highest body-weight. The tion between egg-weight (y) and body-weight (x) n best be expressed by an equation of the form $y = bx^k$, in which b is constant, but k gradually decreases with increasing body-weight. The limiting value of k appears to be 1·0 for low body-weights. The differences in relative egg-weight between different groups remain approximately constant throughout; but in the smaller members of a group of high mean body-size, relative egg-weight is increasing much more rapidly with increasing body-size than in birds of the same absolute size constituting the heavier members of a group of small mean body-size.—J. T. **Cunningham**: Natural ambicoloration and the production of pigment in flat-fishes. The coloration of the lower side in naturally ambicolorate specimens is not due to the action of light, but seems to be rather a mutation arising from some abnormal condition in the gametes and fertilised eggs.

EDINBURGH.

Royal Society, Mar. 14.—J. H. **Ashworth**: Distribution of anopheline mosquitoes in Scotland. Three species occur, as in England, namely, *A. maculipennis*, *A. bifurcatus*, and *A. plumbeus*. The first is known from only four localities in Scotland, *A. bifurcatus* from 36 localities—this being apparently the most abundant and widespread species—and *A. plumbeus* from eight localities, all in proximity to the east coast or to its estuaries, but except for the Clyde area the west is practically unexamined. The areas in which ague was common in the eighteenth century are unfortunately those in regard to which little or nothing is known of their mosquitoes; there is therefore no basis for a consideration of the present distribution of Anopheles in relation to the former distribution of ague. In the single recent case of indigenous malaria, the history of which points to infection having been acquired at Kirriemuir (Forfarshire) early in August 1919, the mosquito probably acquired the organism (*Plasmodium vivax*) from an infected soldier there.—A. D. **Hobson**: A study of the fertilisation membrane in the echinoderms. Confirmation is given of the view that the zona pellucida is unnecessary for the formation of the fertilisation membrane. Artificial activation of the eggs of *Asterias rubens* by isotonic solutions of various salts is accompanied by normal membrane formation and shows that a decrease in surface tension is unnecessary for this process. These eggs may be partially activated by sperm during the earliest stages of maturation and show formation of Seifriz's 'protoplasmic papillæ.' Fertilisations of eggs of *Echinus miliaris* were made in media of varying pH and salinity. Under these conditions, elevation of the membrane is caused by the presence of proteins beneath it; the membrane is completely permeable to salts but impermeable to colloids from the time of its first appearance.—W. L. **Calderwood**: Salmon of the River Grand Cascapedea, Canada. Scale examination of a sample of 182 fish from this river shows that the early river life is retarded, the great majority of the fish descending to the sea when three years old. The high average of 23 lb. amongst the adult fish caught is accounted for by the absence of grilse and small spring fish. No grilse has ever been taken in the river. Three consecutive years' feeding in the sea is recorded on the scales of the great majority of the catch.

PARIS.

Academy of Sciences, Feb. 21.—Charles **Moureu**, Charles **Dufraisse**, and René **Chaux**: Autoxidation and anti-oxygen action (xxi.). Experiments at higher temperatures. Application to the problem of the mode of action of the antidetonants. Details of the experimental study of the rate of oxidation by gaseous oxygen at 100° C. of paraffin wax, petroleum, naphthalene, tetrahydronaphthalene, decahydronaphthalene, some animal and vegetable oils. The effect of the addition of various catalysts in slowing down or accelerating the oxidation has also been studied. Starting with the conception that detonation in internal combustion engines (knocking) is due to the formation of peroxides in the liquid phase, a new theory of the action of antidetonants is developed.—Pierre **Weiss**: The atomic moment in complexes of the iron group.—Henri **Villat**: An extension of the method of Oseen.—W. **Slebodzinski**: The quadrics of Riemann space of three dimensions.—Paul **Alexandroff**: The decomposition of space by closed ensembles.—Paul **Mentré**: Certain displacements of a quadric in ruled projective space.—Georges **Bouligand**: Potential and some connected theories.—André **Roussel**: Equally continued functions.—Paul **Flamant**: The development of a linear transformation in a series of powers of the derivative and the extension of a distributive transformation.—Florin **Vasilesco**: The limit values of harmonic functions.—Gr. **Fichtenholz**: The integration of suites of summable functions.—Th. **De Donder**: The relativistic quantification of continued systems.—Henri **Gutton** and Jean **Clément**: The dielectric properties of ionised gases.—G. **Foex** and Mlle. A. **Brunet**: The magnetic properties of manganese pyrophosphate at various temperatures; measurement of the moment of the Mn″ ion. Manganese pyrophosphate follows the law of Weiss exactly over the temperature range, −80° C. to +485° C. The atomic moment of the Mn″ ion is found to be 30 magnetons.—Nicolas **Perrakis**: The constant paramagnetism of pentavalent vanadium; V_2O_5, both in the solid state and in solution, has constant paramagnetism $64·4 \times 10^{-6}$.—Albert **Pérard**: Metrological researches on some neon and helium lines.—C. V. **Raman** and K. S. **Krishnan**: The constant of magnetic double refraction of benzene. On the basis of some simple hypotheses on the structure of the benzene molecule and on the optical anisotropy of the same molecule, the value of the Cotton-Mouton constant can be calculated.—A. **Piccard** and E. **Stahel**: The ether wind. Reply to a criticism of E. Brylinski.—R. **Descamps**: The anomalous rotatory dispersion in the ultra-violet of three aqueous solutions of tartaric acid containing boric acid. With the aid of a photographic spectropolarimeter, measurements of the rotatory power of tartaric acid solutions containing boric acid for wave-lengths varying from λ5780 to λ2537 were made. Contrary to the conclusions of Lowry and Martin, it is found that the $1/[\alpha]$, λ^2 diagrams are not straight lines, and the curves of rotatory dispersion appear to belong to the anomalous complex type in Lowry's classification.—J. **Errera**:

The specific inductive capacity of heterogeneous mixtures.—Charles **Prévost**: Some derivatives of 1 . 3 . 5-hexatriene —**Lespieau**: True doubly acetylenic linear hydrocarbons, $C_{12}H_{18}$, and $C_{20}H_{34}$. Details are given of the preparation and properties of $CH \cdot C—(CH_2)_8—C \cdot CH$ and $CH \cdot C—(CH_2)_{16}—C \cdot CH$.—Maurice **Delaville**: Comparative migratory aptitude of the phenyl and diphenyl groups.—P. **Nottin**: Study of the deposit of starch on the tables of starch factories. It is shown that the conditions realised in the industrial preparation of starch are such that a large proportion of the smaller granules is lost in the waste liquors. An improvement is to be expected if the tables are not inclined.—Mlle. V. **Malychef**: The podzolic soils of the north-west of Tunis.—G. **Ollivier**: The tetrasporangia of *Falkenbergia Doubletii*.—Pierre **Dangeard**: The nucleus and nuclear evolution in the Bangia.—H. **Vignes** and **Coisset**: Calcium and halogen contents of the organism in the course of gestation.—H. **Labbé** and A. **Kotzareff**: The action of radium emanation on glycæmia in white mice —Maurice **Azéma**: The accumulation of fatty reserves by the kidney of *Ascidia mentula*.—J. **Chaine**: The progressive loss of the posterior insertions of certain cephalic muscles.—E. **Derrien**: Porphyrins and parasite worms. The use of Wood's light for the detection of parasites in meat —E. **Kohn-Abrest**. The estimation on the spot of traces of nitrogen peroxide in air.—Léon **Blum** and D. **Brown**: The pathology of uræmia.

GENEVA

Physical and Natural History Society, Feb. 3.—W. H. **Schopfer**: General results on the molecular concentration of the liquids of parasites. The molecular concentration of the parasites depends on that of the medium. There is constant adaptation to a medium the choice of which is caused by other physico-chemical factors still unknown.—L. **Duparc**. The tectonic of Abyssinia. The Abyssinian plateau has undergone an epirogenic movement in steps from the Trias to the Tertiary, with a steady withdrawal of the sea towards the east. A subsidence of recent date has opened a depression (Aouache valley) communicating with the great lakes and with the sea.—Ed. **Claparède**: The greatness of Pestalozzi and its numerical evaluation. If seven contemporary works on pedagogy are arbitrarily chosen the number of pages devoted to Pestalozzi, Rousseau, Herbart, Froebel, Coménius, Locke, Kant, Fénelon, Luther, Rollin, Montaigne, Erasmus, Basedow, Rabelais, the following percentages are found: 24·6, 13·4, 11·8, 9·2, 8·8, 5·8, 4·6, 3·9, 3·8, 3·5, 2·9, 2·9, 2·7, 2 —Sw. **Posternak**: The phosphorus-containing nucleus of milk casein. The nucleus of milk casein containing phosphorus, a proteid elaborated by the maternal organism for the phosphorus nutrition of the young animal, is formed of four serin phosphoric acids.—Em. **Cherbuliez**: The destruction of organic matter with the aid of perchloric acid. The destruction of organic material by oxidation is easily effected, without the intervention of non-volatile substances, with strong sulphuric acid to which has been added some perchloric acid containing a little fuming nitric acid.—G. **Tiercy**: The ionisation of gases and the temperatures of the stars If, applying the formula of M. Saha and of Nernst, in which according to the author it is necessary to correct the constant (Saha's formula), the temperatures of the stars are calculated, the figures found agree remarkably well with those of H N. Russell.

MELBOURNE.

Royal Society of Victoria, Dec. 16.—Gerald F. **Hill**: Termites (Isoptera) from South Sea and Torres Strait Islands. These termites were collected by A. M. Lea in 1924. Of five species representing three genera, obtained in Fiji, two are proposed as new and three are referred to species originally described from Samoa. A number of immature Calotermes from New Caledonia are most probably referable to species previously described from this locality. The above appear to be the first records of termites from Fiji, Rennel, and Murray Islands —F. **Chapman**: A Silurian jellyfish. This new species of a well-preserved jellyfish, *Discophyllum mirabile*, from the Silurian (Melbournian) beds at Brunswick, Melbourne, is closely related to *D. peltatum* J. Hall sp. from the Hudson River series below Troy, N.Y. The Melbo [illegible] fossil has a probable diameter of 6¼ in. It show [illegible] radial and concentric frills of the umbrella, [illegible] gastro-genital pouches and extended tentacles [illegible] forms were fringed Scyphozoa. In associated s [illegible] in which the jellyfish was found there was a [illegible] preserved example of *Bythotrephis gracilis* J. Hall [illegible] which shows the outer cellular layer of the plant.—F. **Chapman**: On a Limestone containing Lepidocyclina and other Foraminifera, from the Cape Range, Exmouth Gulf, Western Australia. The white limestones and chalky beds of this range, discovered by Dr. F. G. Clapp, belong to the older Lepidocyclina series, characterised by *L. dilatata*, a form hitherto unknown in Australian Tertiary deposits. 67 species of foraminifera are recorded, including one new species, *Bolivina spiroplectiformis*, and two species of Ostraceda, *Aglaia clavata* G S.B. and *Cythere lactea* G.S.B., both of which range through the Tertiary in Australia and are found living around the coast. It is concluded that the limestone is of Aquitanian age —Z A. **Merfield**: Total solar eclipse of May 9, 1929. On May 9, 1929, a total solar eclipse will take place and will be visible from northern Sumatra, Malaya, and south Cochin China. This is the only eclipse in the next twelve years to exceed 150 sec. duration. The duration on the west coast of Sumatra will be 5 min. 6 sec., and will afford a splendid opportunity for solar research. A series of meteorological observations has been organised by the Solar Eclipse Circle of the Solar Physics Commission of the International Astronomical Union, and will be made available in due course.—Z. A. **Merfield**: Solar radiation in the Lyman region. From observations made at the total solar eclipse of Jan. 14, 1926, with a moving plate anastigmat grating spectrograph, it is found that Na reaches a height of 3300 km., Ca 1500 km., Ca^+ 10,000 km, Ba^+ 1400 km. Similar results were obtained in Australia in 1922. When the ionisation potentials are taken into account, a comparison of the heights leads to the conclusion that stripped or ionised sodium is not supported by radiation pressure, and as a corollary, that solar radiation is deficient in the Lyman and far ultra-violet regions. The intensity of bright line emission in the far ultra-violet due to highly ionised atoms (taking Ca^{++} as a typical example) depends on a mobile equilibrium and, as a result, radiation from this source is also weak. Solar radiation in this region of the spectrum does not appear to play any important part in the ionisation of the earth's upper atmosphere.—F. Erasmus **Wilson**: New Australian Coleoptera, with notes on some previously described species, Part iii. This paper deals mostly with minute beetles belonging to the family Pselaphidæ, of which thirteen species are described, belonging to the following genera: Schistodactylus (1), Narcodes (2), Schaufussia (1), Pselaphus (6), Tyromorphus (2), and Tmesiphorus (1). A species of Daulotypus belonging to the family Endomychidæ and a species of Techmessa of the family Oedemeridæ are also described as new.

Official Publications Received.

BRITISH.

Transactions of the Royal Society of Edinburgh. Vol. 55, Part 1, No. 7 The Igneous Geology of Ardsheal Hill, Argyllshire By Frederick Walker. Pp 147-157+1 plate. 1s. 9d. Vol. 55, Part 1, No 8. On a Tetracotyle in the Brain of the Minnow By Prof. J H Ashworth and Janet C. W. Bannerman Pp 159-172+1 plate. 2s Vol. 55, Part 1, No 9: A Critical Examination of the Vittarieae with a View to their Systematic Comparison. By Dr. S. Williams Pp. 173-217+3 plates. 6s. 6d (Edinburgh: Robert Grant and Son; London. Williams and Norgate, Ltd.)

Committee on Education and Industry in Scotland First Report Pp. 32. (London: H.M Stationery Office.) 1s. net.

Proceedings of the Royal Society of Edinburgh, Session 1926–1927 Vol. 47, Part 1, No. 4: The Evaporation of Water and Salt Solutions from Surfaces of Stone, Brick and Mortar. By Principal A. P. Laurie and John Milne. Pp. 52-68+1 plate. 1s. 0d. Vol. 47, Part 1, No. 5. The Distribution of Intensity in the X-ray Spectra of the Normal Saturated Dicarboxylic Acids, their Diethyl, and Mono-Ethyl Esters. By Alexander R Normand, John D. Ross and Edward Henderson. Pp 69 80. 1s. (Edinburgh Robert Grant and Son; London: Williams and Norgate, Ltd.)

Department of Agriculture, Jamaica Entomological Circular No. 12: Insecticides and Fungicides. By C. C. Gowdey Pp 12 (Jamaica Government Printing Office, Kingston.)

Brighter Biochemistry: being the Illustrated Journal of the Biochemical Laboratory, Cambridge. No. 4, February. Pp. 40. (Cambridge. Sir William Dunn Institute) 2s. 6d.

Proceedings of the Royal Physical Society for the Promotion of Zoology and other Branches of Natural History, Session 1925–26. Vol. 21, Part 2. Pp 33-108. (Edinburgh: Oliver and Boyd) 7s. 6d

The Solar Eclipse of 1927. Catalogue of Books on Astronomy in the Wigan Public Libraries; together with a Note on the Total Eclipse of the Sun to take place on Wednesday, June 29th, 1927, and a Map showing the Area of West Lancashire under the Shadow. Compiled by Arthur John Hawkes Pp. 14. (Wigan: Central Public Library.) 3d.

Journal of the Chemical Society containing Papers communicated to the Society. February Pp iv+iv+231-531. (London Gurney and Jackson.)

Memoirs of the Department of Agriculture in India Veterinary Series, Vol. 3, No. 7: Experiments on the Treatment of Hookworm Infection in Dogs. By Amarnath Gulati. Pp. 167-185. 11 annas; 1s. 3d Veterinary Series, Vol 3, Nos. 8, 9: On the Occurrence of a Lung Fluke *Paragonimus edwardsi*, n sp., in a Palm Civet (*Paradoxurus grayi*) in Kumaon Hills, by Amarnath Gulati; On the Occurrence of *Isospora* and *Balantidium* in Cattle, by Hugh Cooper and Amarnath Gulati. Pp. 187-193+2 plates 4 annas; 6d Chemical Series, Vol. 8, No 12: A Study of Absorption of Moisture by Soils. By Dr. Jatindra Nath Sen and Bhailal Motibhai Amin. Pp. 235-253. 6 annas; 9d. Chemical Series, Vol. 9, No. 1: The Selection of Burma Beans (*Phaseolus lunatus*) for Low Prussic Acid Content. By J. Charlton. Pp. 36. 10 annas; 1s. Chemical Series, Vol. 9, No. 2: Bangalore Maintenance Experiments, First Series. By F. J. Warth. Pp 37-61. 11 annas, 1s. 2d. (Calcutta: Government of India Central Publication Branch.)

The Journal of the Indian Mathematical Society. Edited by M T Naraniengar Vol 16, No 12, December. Pp. 265-292+177-192. (Madras) 1 rupee.

Journal of the Indian Institute of Science Vol 9A, Part 7. Reactions of Chromates at High Temperatures. Part ii. The System CaO-Cr_2O_3-O_2. By K. S. Nargund and H. E. Watson Pp. 149-167. 1 rupee. Vol. 9A, Part 8: i, The Catalytic Hydrogenation of Carone, by Subramania Narayana Iyer and John Lionel Simonsen; ii, Conessine, by Darab Dinsha Kanga, Panchandana Ramaswami Ayyar and John Lionel Simonsen. Pp. 169-177 8 annas. (Bangalore.)

Annals of the (Mededelingen van het) Transvaal Museum. Vol. 12, Part 1: Contributions to our Knowledge of the Dermaptera and Orthoptera of the Transvaal and Natal By James A. G Rehn. Part ii: Mantidae. Pp. 64+2 plates. (Cambridge: Printed at the University Press.)

The Welsh Journal of Agriculture: the Journal of the Welsh Agricultural Education Conference Vol 3 Pp. 357. (Cardiff: University of Wales Press Board.) 2s 6d.

The Botanic Gardens, Singapore. Illustrated Guide Pp. 67. (Singapore.) 1 dollar; 2s 4d

Ministry of Health Report of the Departmental Committee on the Treatment of Flour with Chemical Substances. Pp. 24. (London: H.M Stationery Office) 6d net.

Quarterly Journal of the Royal Meteorological Society. Edited by a Committee of the Council. Vol 53, No 221, January. Pp. 93. (London: Edward Stanford, Ltd.) 7s. 6d.

FOREIGN.

Department of the Interior: U.S. Geological Survey Water-Supply Paper 530. Surface Water Supply of the United States, 1921. Part 10 The Great Basin. Pp v+194+2 plates. 25 cents Water-Supply Paper 555: Surface Water Supply of Hawaii, July 1, 1921, to June 30, 1922. Pp. iv+177. 20 cents. Water-Supply Paper 564: Surface Water Supply of the United States, 1923. Part 4 St. Lawrence River Basin. Pp iv+171+3 plates. 25 cents. Water-Supply Paper 592: Surface Water Supply of the United States, 1924. Part 12: North Pacific Slope Drainage Basins A: Pacific Basins in Washington and Upper Columbia River Basin. Pp. v+178+3 plates. 20 cents. Bulletin 788-A: Topographic Instructions of the United States Geological Survey. A: Administration Compiled by H M. Fryer. Pp v+45. 10 cents Professional Paper 137: The Fauna of the Ripley Formation on Coon Creek, Tennessee. By Bruce Wade. Pp ii+272+72 plates. 1 dollar. Professional Paper 147-C American Tertiary Mollusks of the Genus Clementia. By W. P. Woodring. (Shorter Contributions to General Geology, 1926.) Pp. ii+25-49+plates 14-17. (Washington, D.C: Government Printing Office.)

Library of Congress. Report of the Librarian of Congress for the Fiscal Year ending June 30, 1926. Pp. vi+375+5 plates. (Washington, D.C.: Government Printing Office.)

Smithsonian Institution: United States National Museum. Bulletin 137: The Collection of Primitive Weapons and Armor of the Philippine Islands in the United States National Museum By Herbert W. Krieger. Pp. iii+128+21 plates (Washington, D.C. Government Printing Office.)

Jahrbücher der Zentralanstalt für Meteorologie und Geodynamik. Amtliche Veröffentlichung. Jahrgang 1922. Neue Folge, Band 59. Pp. xvi+A30+B30+C42+D8. (Wien. Gerold und Ko)

Publikationer fra det Danske Meteorologiske Institut. Aarbøger. Isforholdene in de Arktiske Have (The State of the Ice in the Arctic Seas) 1926. Pp. 34+5 maps. (København: G E C Gad.)

Proceedings of the United States National Museum. Vol. 69, Art. 19: *Kentriodon pernix*, a Miocene Porpoise from Maryland By Remington Kellogg. (No 2645.) Pp 55+14 plates (Washington, D C.: Government Printing Office.)

Proceedings of the Academy of Natural Sciences of Philadelphia. Vol. 78, 1926, Supplement: Synopsis of North American Diatomaceae. Part i. Coscinodiscatae, Rhizosoleniatae, Biddulphiatae, Fragilariatae. By Charles S Boyer Pp. 228. (Philadelphia, Pa.)

Proceedings of the Imperial Academy. Vol 2, No 10, December 1926. Pp. xxvii-xxviii+521-564+ix+ii. (Ueno Park, Tokyo)

State of California: Fish and Game Commission. Twenty-ninth Biennial Report for the Years 1924–1926 Pp. 127. (Sacramento, Cal)

Bernice P Bishop Museum. Bulletin 29: Ancient Hawaiian Music. By Helen H. Roberts. Pp. 401+5 plates. Bulletin 30: Pyroclastic Geology of Oahu. By Chester K. Wentworth Pp iv+121+22 plates. Bulletin 31: Insects of Hawaii, Johnston Island and Wake Island By E. H. Bryan, Jr., and collaborators (Tanager Expedition, Publication No. 2.) Pp 94. Bulletin 32: History and Traditions of Niue By Edwin M. Loeb. Pp. iv+226+13 plates. Bulletin 33. The Products and Structure of Kilauea. By John B. Stone. Pp. 59+3 plates. Honolulu, Hawaii.)

Proceedings of the American Philosophical Society held at Philadelphia for Promoting Useful Knowledge. Vol. 65, No 5 Pp. xv+381-585. (Philadelphia, Pa.)

Conference on the Future of the Smithsonian Institution, February 11, 1927. Pp 40+7 plates. (Washington, D C: Smithsonian Institution)

Reprint and Circular Series of the National Research Council. No 72: A Bibliography of the Analysis and Measurement of Human Personality up to 1926 By Dr. Grace E Manson. Pp. 59 1 dollar. No. 73 List of Publications of the National Research Council and its Fellows and Partial List of Papers having their Origin in the Activities of its Committees to January 1, 1926. Pp. 70. 75 cents. No 74. The Need for Scientific Research in the Fishing Industries By Maurice Holland Pp 8. 15 cents. (Washington, D.C: National Academy of Sciences.)

Bulletin of the National Research Council. Vol 11, Part 2, No 56. Transactions of the American Geophysical Union, Seventh Annual Meeting, April 29 and 30, 1926, Washington, D.C Pp 184. (Washington, D C.: National Academy of Sciences) 1.25 dollars

Proceedings of the United States National Museum Vol. 70, Art 7: Notes on Cestode Parasites of Birds By Edwin Linton. (No. 2650 Pp. 73+15 plates. (Washington, D.C: Government Printing Office)

State of Connecticut. State Geological and Natural History Survey. Bulletin No. 36: The Uredinales or Rusts of Connecticut and the other New England States. By Dr. Willis Roberts Hunt (Public Document No. 47.) Pp 198. 1 dollar. Bulletin No. 37: Catalogue of the Lichens of Connecticut. By Prof. Alexander William Evans and Rose Meyrowitz. (Public Document No. 47) Pp. 56. 60 cents. (Hartford, Conn)

Department of Commerce: U S Coast and Geodetic Survey. Serial No. 364: Tides and Currents in South-east Alaska By R W. Woodworth and F. J Haight. (Special Publication No 127.) Pp. iv+149. (Washington, D.C Government Printing Office) 35 cents.

Smithsonian Miscellaneous Collections Vol 78, No 6 The Lyell and Freshfield Glaciers, Canadian Rocky Mountains, 1926. By Dr. J. Monroe Thorington. (Publication 2911) Pp. 8+12 plates. (Washington, D.C. Smithsonian Institution)

Department of the Interior: Bureau of Education. Bulletin, 1926, No. 21: Record of Current Educational Publications, comprising Publications received by the Bureau of Education to October 1, 1926. Pp. 24. (Washington, D C: Government Printing Office.) 5 cents

Annales de l'Institut de Physique du Globe de l'Université de Paris et du Bureau central de Magnétisme terrestre. Publiées par les soins de Prof. Ch. Maurain. Tome 4 Pp iv+163. (Paris Les Presses universitaires de France.)

The Royal Colonial Institute at Amsterdam Origin, Scope and Future. By C J Hasselman. Translated from the Dutch by E J. Labarre Second, revised edition. Pp. 104 (Amsterdam)

Department of Commerce. Bureau of Standards. Circular of the Bureau of Standards, No 311 Stucco Investigations at the Bureau of Standards, with Recommendations for Portland Cement Stucco Construction. Pp. 24 (Washington, D.C.: Government Printing Office) 15 cents.

Diary of Societies.

SATURDAY, APRIL 2.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Yorkshire District) (at Town Hall, Bradford), at 2.

INSTITUTION OF BRITISH FOUNDRYMEN (Lancashire Branch) (Annual General Meeting) (at College of Technology, Manchester), at 3.—At 4.—B Hird. Absorbed Gases in Iron and the Creation of Gas Holes in the Casting

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford The Alpha Rays and their Application to Atomic Structure (3).

MONDAY, APRIL 4.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Rev. Dr S M. Zwemer. The Place of Woman in Islam

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

Royal College of Surgeons of England, at 5.—C. H Shattock: Demonstration of Large Intestine.

Society of Engineers (at Geological Society), at 5.30.—G. C. Workman: Some Aspects of Reinforced Concrete.

Institution of Automobile Engineers (Western Centre) (at Merchant Venturers' Technical College, Bristol), at 6 45.—W. G. Huggins. Automobile Repairs.

Aristotelian Society (at University of London Club), at 8.

Society of Chemical Industry (London Section, jointly with Fuel Section) (at Chemical Society), at 8.—Dr. R. Lessing: The International Conference on Bituminous Coals at Pittsburgh.

TUESDAY, April 5.

Royal Institution of Great Britain, at 5.15 —Prof J W. Cobb: Some Properties of Coke (2).

Zoological Society of London, at 5 30.—B G Boulenger: Exhibition of Photograph of a Crab with Abnormal Claw.—Dr. J. Beattie The Anatomy of the Marmoset, *Hapale jacchus* Linn.—Dr. H. H Woollard: On the Brain of the Marmoset, *Hapale jacchus* Linn.—Major R. W. G. Hingston: Protective Devices in Spiders' Snares.

Institution of Civil Engineers, at 6 —I J. Jones and G. Curry. The Enlargement of the City and South London Railway Tunnels.

London Natural History Society (at Winchester House, E.C.), at 6 30.—R. Green. Bird Portraiture.

Institution of Electrical Engineers (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—Annual General Meeting.

Institution of Electrical Engineers (North-Western Centre) (at Engineers' Club, Manchester) (Annual General Meeting), at 7.—F. H. Clough: The Stability of Large Power Systems.

Royal Photographic Society of Great Britain, at 7.—M Barford: Pictures from the Pyrenees.

Society of Chemical Industry (Birmingham and Midland Section) (at University, Birmingham), at 7.15.—A. A King: Ultraviolet Light.

Institution of Automobile Engineers (at Royal Society of Arts), at 7 45.—A P. Young and L Griffiths The High-Tension Magneto, with Especial Reference to its Design, Manufacture, and Service.

Röntgen Society (at British Institute of Radiology), at 8.15 —J. V Sparks: Uses of Lipiodol as an Aid to Diagnosis in Diseases of the Chest.—F Melville: X-Ray Cinematography.

Royal Anthropological Institute, at 8.30 —Dr. C Singer: Tradition and Observation as illustrated by the Herbal 100 B.C. to 1600 A.D.

WEDNESDAY, April 6.

Geological Society of London, at 5 30.—Prof. H. L. Hawkins and Miss S M. Hampton: The Occurrence, Morphology, and Affinities of the Silurian Echinoidea Echinocystis and Palæodiscus.—V G. Glenday and Dr. J Parkinson: The Kateruk Series and Associated Rocks of the Northern Suk Hills (Kenya Colony).

Institution of Civil Engineers (Informal Meeting), at 6.—F. E. Wentworth-Sheilds. Methods of Preserving Structures.

Institution of Electrical Engineers (Wireless Section), at 6 —P. R. Coursey and H Andrewes: Battery Eliminators or Appliances for the Operation of Radio Receiving Apparatus by Energy Derived from Electric Supply Mains

Institution of Sanitary Engineers (at Caxton Hall, Westminster), at 6.—R. C. N. Newport and H. O. Danger: Kingsbury Main Drainage Scheme, 1924–1926

Electrical Association for Women (at E.L.M.A. Lighting Service Bureau, Strand), at 7.—T. Settle: Women's Place in the American Electrical Industry.

North-East Coast Institution of Engineers and Shipbuilders (Graduate Section) (at Bolbec Hall, Newcastle-upon-Tyne), at 7.15.—W. W. Bath: A Modern Power Station.

Society of Public Analysts and other Analytical Chemists (at Chemical Society), at 8 —C. Ainsworth Mitchell and T. J. Ward. The Sequence of Strokes in Writing.—Dr. D. W. Kent Jones and C. W. Herd: (*a*) Some Observations on the Washing of Gluten from Flour, (*b*) A Numerical Expression for the Colour of Flour.—Dr. H. B. Dunnicliff and Kishen Lal: The Determination of Free Mercury in Commercial Products.

Entomological Society of London, at 8.

Royal Society of Medicine (Odontology and Study of Disease in Children Sections), at 8.—A. T Pitts (Odontology), Dr. R Hutchison (Disease in Children), and others: Discussion on Oral Manifestations of General Disease in Children

Royal Society of Medicine (Tropical Diseases and Parasitology Section) (Laboratory Meeting at London School of Hygiene and Tropical Medicine), at 8.

Institution of Naval Architects (at Royal Society of Arts) —Annual General Meeting.

THURSDAY, April 7.

Linnean Society of London, at 5.—G. C. Robson: Exhibition of Preparations and Lantern-slides illustrating Bacterial Luminescence in Cephalopoda.—Prof. J. Percival: The Species and Races of Wheat and their Relationships.

Royal Society of Medicine, at 5.—W. G Spencer, Dr. H. French, Dr. Fortescue Fox, and others: Discussion on Blood-letting.

Royal Institution of Great Britain, at 5.15.—H J. E. Peake: The Beginnings and Early Spread of Agriculture (2).

Institution of Electrical Engineers, at 6.—E. B Wedmore, W. B. Whitney, and C. E. R. Bruce: A Contribution to the Study of the Number of Tests required to establish the Rupturing Capacity of an Oil Circuit-Breaker.

Optical Society (at Imperial College of Science and Technology), at 7.30 —Prof. C. V. Raman: Huygens' Principle and the Phenomena of Total Reflection —H. W Lee: The Hartmann Formula for the Dispersion of Optical Glass.

Chemical Society, at 8.—H. King: Trypanocidal Action and Chemical Constitution. Part VI. Amphoteric *s*-carbamidoarylarsinic Acids.—E. J. B. Willey: On Active Nitrogen. Part III. Active Nitrogen and the Metals.

Harveian Society of London (at Paddington Town Hall), at 8.30.—T. P. Dunhill, Dr. C. M. Wilson, and others. Discussion on the Treatment of Graves's Disease

Institution of Naval Architects (at Royal Society of Arts).—Annual General Meeting.

Oil and Colour Chemists' Association.

FRIDAY, April 8

Royal Astronomical Society, at 5.—Prof. E W. Brown. Note on Dr Fotheringham's Paper entitled "Trepidation"—P A. Curry The Effect of reversing a small Transit Instrument

Royal Society of Medicine (Laryngology Section), at 5.

Royal College of Surgeons of England, at 5.—Sir Arthur Keith: Demonstration of the Anatomy and Physiology of the Cæcum and Appendix Vermiformis

Malacological Society (at Linnean Society), at 6.

Women's Engineering Society, at 6 30.—Miss E. M. Kennedy: A Business Woman's Trip to America.

Junior Institution of Engineers, at 7.30 —E. Ambrose: Electrical Osmosis.

Institute of Metals (Sheffield Local Section) (at Sheffield University), at 7 30 —E. A Smith: Refined Silver for Electro-plating Anodes.

Royal Society of Medicine (Electro-Therapeutics Section), at 8.30.—Prof. S Russ and Miss G. M. Scott: (*a*) The Growth of Tumours in Tissues Exposed to X-rays and Radium; (*b*) The Action of Radon Seeds upon Tumours and Some Normal Tissues of the Rat.—Dr. J C. Mottram: On the Co-relation between the Experimental and Clinical Radiation of Tumours

Royal Institution of Great Britain, at 9.—Sir Ernest Rutherford: Early Days in Radio-activity.

Institution of Naval Architects (at Royal Society of Arts) —Annual General Meeting.

Oil and Colour Chemists' Association (Manchester Section).—Annual General Meeting.

SATURDAY, April 9.

Royal Institution of Great Britain, at 3.—Sir Ernest Rutherford: The Alpha Rays and their Application to Atomic Structure (4)

PUBLIC LECTURES.

SUNDAY, April 3

Guildhouse (Eccleston Square), at 3.30 —Prof. J. P Bruce: Confucianism.

THURSDAY, April 7.

Fulham Central Public Library, at 8.—J. Weathers: Some Common Mistakes in Gardening.

SUNDAY, April 10.

Guildhouse (Eccleston Square), at 3.30.—Rev. Father Andrew: Christianity.

COMMEMORATION.

Lister Centenary, April 4, 5, and 6.

April 4, at 3.—King's College Hospital.—Sir Watson Cheyne, Bart, Sir Lenthal Cheatle, and others: Lister's Personality.—At 8.30.—Royal Society of Medicine.—Sir StClair Thomson: The Centenary of Lister, Personal Recollections by One of his House-surgeons

April 5 (at British Medical Association, 19 Tavistock Square, W.C), at 11.30 A.M.—Reception of Delegates by the Prime Minister.—At 4.—Conversazione at Royal College of Surgeons of England.

April 6 (Westminster Abbey), at 11 15.—Bishop of Birmingham: Address.—(At Royal Society of Medicine, 1 Wimpole Street, W), at 8 —Discourses by Sir Charles Sherrington, Prof W. Bulloch, and Sir Berkeley Moynihan, Bart., on Lord Lister as Physiologist, Bacteriologist, and Surgeon.—At 9.—Conversazione at Royal Society.

CONFERENCES.

April 7 to 9.

Tuberculosis Society and Society of Superintendents of Tuberculosis Institutions (at Oxford).

April 7, at 2.30 —Prof. L. Cummins: The Bovine Tubercle Bacillus in Immunisation.

April 8, at 10 A.M —Dr. Leonard Hill and others: Discussion on the Defensive Mechanism of the Body against Tuberculosis from the Physical and Chemical Aspect —At 2.15.—Dr. J. Freeman: The Defence of the Body from the Bacteriological and Immunological Side.—Dr. A. G. Gibson. Secondary Infections in Relation to the Progress of Pulmonary Tuberculosis.—Dr A. D. Gardner: The Laboratory Diagnosis of Tubercle.

April 9, at 10 A.M —Dr. J M Martin, Dr. D P Sutherland, and Dr. P. Edwards: The Gaps and Flaws in the Public Health Administration of Tuberculosis.

April 20 to 24.

Journées Médicales Marseillaises et Coloniales (at Marseilles).—Prof. Cantacuzène: The Rôle of the Streptococcus in the Etiology of Scarlet Fever.—Dr. Mayer: Recent Advances in the Treatment of Cancer.—Prof. Ottolenghi: Malaria.—Dr. N. Bernard. Beri-beri.—Prof. Imbert: Bone-grafting

April 25 to 28.

German Society for Internal Medicine (at Wiesbaden) —Discussions on Psychotherapy, introduced by Gaupp and Fleischmann; Results of Recent Functional Investigations of the Stomach and Duodenum, introduced by G Katsch.—A joint meeting with the German Rontgen Society will be held on April 28, with a discussion on the Significance of Rontgen-ray Examination of the Lungs and Mediastinum for Internal Medicine (excluding Tuberculosis), introduced by Dietlen, Assmann, Haenisch and Lorey, and Fleischner.

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Technical Education and Industry.

If any apology were needed for our return to the third volume published by the Committee on Industry and Trade,[1] we would refer our readers to the articles and reports dealing with education and industry which have appeared in our columns during the last two years or so. If those articles and reports be carefully scrutinised, it will be seen that we have attempted, very deliberately, to show not only the necessity, but also the origins, directions, and even deflexions of the rapidly growing tendencies towards a scientific view of education in relation to the structure of modern society. We venture to suggest, too, that our interpretation of the term 'scientific education' has been wide and liberal enough to satisfy the most suspicious guardian of the delectably elusive qualities which are covered by the word 'culture.' Perhaps at another time we shall demonstrate the possibility of realising some of the classical ideals which are still inherent in the life of a community developing under an apparently grey and formless industrialism. In the meantime, the attitude of the present volume towards technical education has a special attraction from the point of view of its significance to the educational movements we have been observing.

Whatever may be our notions of the contributions which are made towards the solution of the problems before the Committee, we believe that its attitude towards the relationship of technical education to industry will do much to strengthen that relationship, and so aid, not only in the industrial reconstruction which lies ahead, but also in the general intellectual progress towards a less anomalous civilisation than exists at present.

It would be easy, perhaps, to criticise the chapter on technical education on certain grounds, the chief of which might be that it is based upon memoranda supplied by government education departments, and that it presents the usual shortcomings of memoranda from such sources, namely, a certain timidity and a platitudinous repetition of possible improvements. But it must not be forgotten that what is platitudinous to the expert may be illuminating and inspiring to the layman; and this volume is primarily for business men rather than for educationists. The charge of timidity, too, loses much of its power when we read the Committee's warning that the volume "is not concerned with recommendations. Its aim is to assemble and analyse facts and tendencies, and by so doing to narrow the range of economic controversy and prepare the way for the intelligent study of the problems by which British industry is confronted."

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[1] Committee on Industry and Trade. Factors in Industrial and Commercial Efficiency: being Part I. of a Survey of Industries. With an Introduction by the Committee. Pp. v+544. (London: H.M. Stationery Office, 1927.) 5s. net.

Three necessities are, however, made clear: expansion of the scope and number of technical classes; the better adjustment of their relationship with industry; and the constant need to adjust the relations of general and technical education.

Further, if the Committee does not profess to give detailed recommendations, its survey of the present relationship of technical education to particular industries, and its suggestions as to possible improvements, will be greatly helpful to any national industrial organisation, group of employers, or individual employers. Clearly the Committee is doubtful whether full co-operation can be reached by local advisory committees alone. It realises that as yet there has been little serious study on the side of industry of the possibilities of a considered policy of technical school training for young employees; and it is certain that substantial improvements could be suggested if each industry would survey, from its own point of view, the existing facilities, see what gaps need filling and what developments are desirable, take an active interest in the schools and give effective assistance to their conduct. That assistance could take many forms. Lectureships could be founded or subsidised where the public provision is inadequate; grants to part-time teachers to help them to gain wider experience or to improve qualifications; scholarships to promising students; consideration of the methods of filling the more responsible posts; consideration of the number of men needed annually, and the kind of qualifications they should possess; allowance of 'time-off' during working hours to students who have shown diligence and ability to profit by instruction in technical schools.

Three other serious weaknesses of the present system are indicated. The connexions between universities and technical schools are accidental rather than systematic, even though some technical institutions are of university rank and function as technical universities. Premises, too, are unsatisfactory, and work is sometimes conducted "under conditions which are tolerated rather than approved." Finally, the training of teachers presents a difficult problem. Obviously men of experience and skill in trades and processes they teach are essential. But more than such experience and skill is necessary if the highest results are to be attained. Vacation courses have proved extremely valuable; but these, in themselves, are not sufficient. By what other means can this vital problem be settled?

The Committee's view of its problems is shown excellently in some passages which are worthy of reproduction:

> "The vitality of modern industry, like that of an organism, is measured by its power of response to external stimulus and of self-adaptation to modern environment. Mobility (in this sense of the term) does not imply incessant and purposeless movement or change. . . . But it does imply the power of spontaneous reaction to changes in economic conditions and of internal modifications and rearrangement to meet such changes. . . . It applies to modes of preparation for industry and the right adjustment between the functions of school education and workshop training which demand continual modification and re-adaptation both to fit the changing needs of modern large-scale industry and to counteract some of the dangers of excessive sub-division of employments."

Following this line of thought, the Committee does not fail to observe that in our age of flux and transformation, no plan of educational development can be justified which does not maintain unimpaired initiative, flexibility of temperament, powers of adaptation and capacity for co-operation among all the partners in production and distribution. Such a view ought to show very clearly to those who may be fearful, that mere vocational instruction is by no means what the Committee understands by the term 'technical education.'

It would, after all, be too much to expect from a single committee—and particularly from a committee with such wide terms of reference—a solution of the delicate, far-reaching, and many-sided problems presented by an attempt to examine the relationship of technical education to industry. It must not be forgotten that other bodies are also making their contributions to these problems; and if we indicate only some of the activities which we have been observing, it will be sufficient to justify the remark we made above concerning "rapidly growing tendencies."

The Board of Education's Consultative Committee has presented its report on the education of the adolescent; a Committee on Education and Industry (under Mr. D. O. Malcolm) has presented the first part of its report, and is preparing the second part; a Ministry of Labour Inquiry into the general question of apprenticeship is not yet completed; the League of Nations recently held a conference on conciliation in industry, and will shortly continue that conference at Geneva;

finally, the committee brought into being by the many learned and professional institutions and teaching associations under the chairmanship of the late Lord Emmott, is now in the stages of compiling its report on the relationship of technical to other forms of education and to industry. When such activities are reviewed the importance of the present volume may be rightly judged, especially when it is recalled that the President of the Board of Education informed a deputation of the Emmott Committee, last May, that not until he had before him the reports of at least four of these bodies could he begin to formulate the changes which may be immediately necessary.

The contribution of the present volume, too, falls further into its place when we note that it divides its educational problem into three main parts: industrial output is not a mere question of volume, but depends essentially on quality; under modern industrial conditions the relative range and potency of apprenticeship have tended to diminish; school education before entering, and concurrently with, employment has increased in importance.

There is not yet any consensus of opinion, however, as to the mutual relations and limits of workshop training and school education, looked upon as complementary factors. In making its surveys of technical education and apprenticeship, the Committee hoped to be "of assistance in arriving at clearer views on this vitally important question." That the volume achieves that object is beyond all doubt.

Politics as a Science.

The Science and Method of Politics. By Prof. G. E. G. Catlin. Pp. xii + 360. (London: Kegan Paul and Co., Ltd.; New York: Alfred A. Knopf, 1927.) 12*s.* 6*d.* net.

THIS is an able and interesting volume, in which there is at once great learning and considerable power of speculation. Prof. Catlin has an important thesis to maintain, and his urbanity of manner will not conceal from the reader that he is prepared to maintain his ground against all comers. The field, indeed, is already, as if in advance of conflict, strewn with the illustrious dead; at least I seem to discern there the scalps of Plato and Aristotle, Kant and Hegel, exposed as a warning to prospective combatants.

In a sense, Prof. Catlin's book is difficult to review; for it is to be followed by a book already in preparation in which the thesis he here lays down is to be applied to our problems. Obviously, therefore, we shall not fully know what the method he advocates can do until he himself has applied it; and conclusions upon his analysis must be provisional until he has given us the full opportunity to see it at work. But as I understand his views, his purpose is to construct a science of politics which shall seek to do for man in society what the early economists did for the phenomena they survey. It will be abstract and deductive; it will have its axioms and postulates; and the test of its validity will lie in the verifiability of its predictions. Such a science, he argues, must free itself from the shackles which the historian and the philosopher have sought to impose upon it. For values it will have no concern. It will be concerned only with the observed behaviour of men. Assuming that there is a political man with the appetite for power, it will seek to construct the laws of his behaviour in adjusting means to purpose. With right or wrong it will have no more concern than the chemist with the moral qualities of hydrogen. It will be quantitative in character in that, upon the basis of its assumptions, it will seek from observation the largest possible number of examples from which to draw its conclusions. Having made abstraction of ethics, it will be able to approach the facts without a *parti pris*; and, instead of offering futile sacrifices upon the altar of teleology, it will be able to say (p. 199) that the "social situation only admits of certain appropriate measures." For studying what men do, it will be able to tell us what they will do; between the two Prof. Catlin injects a formidable *therefore*; and as this science of politics is refreshed by the constant accumulation of facts about the behaviour of men in their desire for power, as, also, such sister sciences as psychology contribute their due quota of knowledge, we may hope for the discovery of truths which will have value and influence of the same magnitude as those to which the economists have given birth.

There is an air of promising certitude about these propositions, which have at least the merit of interesting audacity; though I observe with a little surprise that Machiavelli is appealed as their benevolent compurgator. For if ever a man had a definite end in view (which, as a passionate Italian patriot, he would have regarded as ethical), if ever, also, a man selected his facts to suit the thesis his experience dictated as best suited to his end, that man was Machiavelli. Perhaps the best thing one can do is to indicate, though with appreciation, some of the doubts to which Prof. Catlin's argument gives rise. The victories of economic science as built in terms of 'economic man' seem to me less outstanding than he claims, and its main successes have been won in spite of, rather than because of, its original and rigorous abstraction. The chief influence of the late Prof. Marshall, for example, was mainly due to the ingenuity with which he transformed the classic economics into something approaching the complexity of the facts; in no other way, moreover, could the economists answer the challenge of Marx, whose own 'economic man' led, by the technique of his construction, to quite different conclusions.

Prof. Catlin, moreover, has a simple faith in facts as such, which, in the social sciences, at least, I do not find it easy to share. They are not born free and equal. The expert interpretation of a social environment is coloured by the personal equation of the observer in a way that is momentously different from an expert interpretation of a physical or chemical environment. What Mr. Justice Holmes has called the 'inarticulate major premiss' of the judiciary is, as a rule, the main clue to their decisions; and yet the best of judges usually believe that they are finding the law in an unbiassed and scientific way. Nor is this all. The maxim 'as men behave, so they will behave,' is, statistically, probably true in a static world; the trouble with this world is that the environment changes at a pace so rapid that the forms of behaviour in one place or period are no clue to those forms in another. I agree that most social situations admit only of certain appropriate measures. But the difficulty here (and I cannot find that Prof. Catlin deals with it) is that the measures have to be chosen in terms of an end deemed right or wrong. We are, in fact, at once outside the realm of scientific politics; for here we are dealing with argument that has reference to ethical value which Prof. Catlin deems irrelevant. I would venture here to add that if the 'political man' were what he describes him to be, in any sense that can be called significant, he represents so small a proportion of mankind that prediction built upon his behaviour would be no clue to the general habits of men. I wish, indeed, that Prof. Catlin had given us some examples of the political 'laws' that his science would establish. Provisionally, at least, he still leaves me with the impression that Burke's 'little mirror of circumstances' would be vital in the battle.

Perhaps I may put my difficulty in terms of an analogy. The Common Law for long proceeded upon the assumption (akin in character to that of Prof. Catlin) that where there was no remedy there could be no wrong; and in order that it might be adequate and effective it was necessary to invent the remedies of Equity, which proceeded upon the assumption (akin to that of political philosophy) that wrongs as such were entitled to redress. My own conviction is that Prof. Catlin's science of politics would need a similar supplement. What seems to me really valid (and brilliantly demonstrated) in his book is its plea for the systematic collection of facts and the deliberate undertaking of experiment. We need, in fact, an inductive study of politics, based on quantitative tabulation, instead of deductions moulded from our private desires. To have shown with wit and point and learning how much might be expected from such a development is the very considerable service Prof. Catlin has rendered us.

Harold J. Laski.

Synthetic Organic Chemistry.

(1) *The Synthesis of Benzene Derivatives.* By Stanley C. Bate. Pp. 229. (London: Ernest Benn, Ltd., 1926.) 21*s*. net.

(2) *The Use of Solvents in Synthetic Organic Chemistry.* By Prof. Donald W. MacArdle. Pp. vii+217. (London: Chapman and Hall, Ltd., 1926.) 15*s*. net.

(3) *Organic Syntheses: an Annual Publication of Satisfactory Methods for the Preparation of Organic Chemicals.* Editor-in-Chief: Carl Shipp Marvel. Vol 5. Pp. vii+110. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1925.) 7*s*. 6*d*. net.

THE ever-growing output of research that marks the progress of chemical science is reflected in the increasing size of the chemical journals; and the task of the researcher whose text-books these form becomes more onerous each year. The work is lightened by the publication of the Chemical Society's Annual Reports, and by the appearance from time to time of monographs dealing with the more important theoretical aspects of the problems under investigation, but the wealth of information 'tied up' in the experimental work of the original papers is not so easily rendered accessible. This difficulty has been partially solved by the compilation of such comprehensive treatises as Houben-Weyl's "Die Methoden der organischen Chemie," or Meyer's "Analyse und Konstitutionsermittlung organischer Verbindungen," and the first two of the three books under review are frank attempts on the part of the authors to provide for English-speaking chemists similar correlated information on definite problems connected with laboratory practice.

(1) Mr. Bate seeks to give in a short and concise form the various methods available for the synthesis of organic compounds that may be of utility both to senior students and research chemists; and the present pioneer volume is concerned with the synthesis of derivatives of benzene. The subject is discussed in twelve chapters, each dealing, usually, with one type of reaction. Thus in the chapter on nitro compounds, the nitration of different types of compounds by means of nitric acid is described; then follows a description of other methods of nitration; of the conversion of amines into nitro compounds; of anomalous cases occurring in nitration; and finally, the effect on certain groups of the presence of the nitro group in the molecule is discussed. The text contains full references to the original papers and patents up to April 1925, as in very few cases is sufficient detail supplied to make the reader independent of the original memoir. The reviewer suggests that in a future edition the names of the investigators be given as well as the references, in order to facilitate cross reference to abstract journals; and also, that the present scanty index be considerably extended.

The general arrangement of the book is excellent, the printing clear, and the text remarkably free from errors, but in a few cases confusion arises from the use of italics at the beginning of a paragraph for the introduction of a new main section, whilst a sub-section is placed under headlines in heavy type. Not a few formulæ are faulty owing to the misuse of the dot and bracket; and the printing of such expressions as "to react the substance," and "the substance to be amidated," and "oxy" for "hydroxy," are not pleasing to the English ear. These minor blemishes do not detract from the value of a book of such excellence that it should form a unique and most useful addition to the reference library of the organic chemistry departments of all university and technical institutions.

(2) Prof. MacArdle's book is the first part of a treatise on the operative technique of synthetic organic chemistry, similar in a general way to the first sections of the well-known German works of Lassar-Cohn and of Weyl. The first chapter is devoted to "General Considerations," and treats of solution, methods of bringing about solution, choice of solvent, interliquefaction, crystallisation, solvent of crystallisation, and mixed crystals. In the following seven chapters the uses of the various types of solvents are discussed, the question of the purifying of the substance being treated critically and the fullest practical details being supplied. These chapters are rich in references to special cases in which the solvent in question has proved of unique value, and also of instances when anomalous reactions have occurred which limit the use of the solvent. The remaining two chapters are devoted to a consideration of "Special Means to Induce Crystallisation" and to "Salting Out"; a full bibliography and two exhaustive indexes are appended.

The arrangement of the book and the presentation of the subject leave nothing to be desired; for, in addition to its eminently practical value, the book is a readable one and holds the interest of the reader from the first page to the last.

The statement on page 138 that the dangers attending the use of dimethyl sulphate have been very much exaggerated cannot be generally endorsed, for in the experience of the reviewer more than one case of serious and prolonged indisposition has resulted from the use of this substance without special precautions being taken to remove all vapours in an effective draught.

(3) The last of the three books with which this review is concerned differs widely in scope and purpose from the others. It is the fifth volume of "An Annual Publication of Satisfactory Methods for the Preparation of Organic Chemicals"; and indeed so eminently satisfactory are the methods described therein that the issue of the yearly volume marks a red-letter day in the organic laboratory. Since the publication of the first volume, when the editors invited the co-operation of other organic chemists, the response has become wider each year, and in this volume twenty-four of the thirty-three preparations have been submitted by eighteen contributors.

M. A. W.

The American Mongolian Expedition.

On the Trail of Ancient Man: a Narrative of the Field Work of the Central Asiatic Expeditions. By Dr. Roy Chapman Andrews. With an Introduction and a Chapter by Henry Fairfield Osborn. Pp. xxiv + 375 + 61 plates. (New York and London: G. P. Putnam's Sons, 1926.) 25s. net.

NORTH-EASTERN Asia has entered the field as one of the competitors with south-western Asia as the home of man. The discovery of some fossil vertebrates that are common to Europe and western America but are absent from eastern America led Prof. H. F. Osborn in 1900 to predict that these animals had developed in northern Asia and thence migrated eastward into Europe and westward into America. The ocean they crossed was therefore the Pacific and not the Atlantic. Faith in this theory led Dr. R. C. Andrews to organise an expedition to search for the remains of these animals in the steppes which they must have crossed during their migration from inner Asia to the Rocky Mountains. The generosity of American patrons of science provided £50,000 for the purpose, and Dr. Andrews led to Mongolia a series of well-equipped expeditions which there made several sensational discoveries. The most dramatic was the finding of the eggs of Cretaceous dinosaurs. They were found in such abundance in one locality that one Mongolian woman brought in fragments of egg-shells in tinfuls. The eggs belong to three genera, one of which, Protoceratops, is a primitive form of the Ceratopsidæ. Dr. Andrews describes this locality as a dinosaur incubator, and he attributes its selection as the breeding-ground to the nature of the sand, which would have formed comfortable nests.

Of still greater importance was the discovery, also in the Middle Cretaceous beds, of some mammal skulls. The first found had been sent to New York as a reptile, and recognised by Dr. W. D. Matthew as a primitive mammal. Stimulated by his report of the importance of the discovery, the search was renewed and other specimens found. A preliminary account of the skulls is given in the volume, but a more detailed account has been recently published elsewhere. The expedition also discovered a series of important Eocene mammals. The first of the vertebrate fossils found by the expedition were some bones of the Baluchitherium, an Oligocene mammal, which was discovered by Cooper in northern India. The expedition found later a skull and a skeleton of this mammal, and Dr. R. C. Andrews was led by the discovery to the expectation that, as the human family probably began to diverge from the ordinary primates in the Oligocene, the remains of some primitive ancestors of man should be found in Mongolia.

Large numbers of stone implements were found; they represent two periods—Neolithic and Upper Palæolithic. The age of the latter is suggested as Azilian. Some members of the expedition were at first under the impression that the rough stone cores represented a pre-Chellean culture; but ultimately they were convinced by the large series collected and arranged by the archæologist, Mr. Nelson, that the cores were the residue of Upper Palæolithic flaking. Nothing human was obtained by the expedition earlier than the Mousterian, of which implements have already been found in China, in the valley of the Hoang-ho. While the palæontologists were excavating the fossils, the two geologists with the expedition—Prof. Berkey and Mr. F. K. Morris—surveyed the area, worked out its history, and thus made a valuable contribution to Asiatic geology. Amongst other points of interest they find that there is no evidence of glaciation in the district, except in some small corries on the highest hills.

The volume tells the narrative of the expedition. It is graphically and racily written, and gives a delightful picture of a group of men in cordial co-operation and all enthusiastic in their work. Probably in the effort to be popular the author constantly states the age of the beds in years, reporting, for example, that the earlier implements date from 40 thousand, and the later from 15 thousand years ago; such estimates are about as useful as if a historian tried to date an Act of Parliament by reference to the birth of John Smith. The book is well illustrated by photographs showing the expedition at work and the nature of the country, and by ideal pictures of the fossils skipping about in their native haunts. J. W. Gregory.

Our Bookshelf.

The Year-Book of the Scientific and Learned Societies of Great Britain and Ireland: a Record of the Work done in Science, Literature, and Art during the Session 1925–1926, by numerous Societies and Government Institutions. Compiled from Official Sources. Forty-third Annual Issue. Pp. vii + 399. (London: Charles Griffin and Co., Ltd., 1926.) 18s. net.

To those who have used this work of reference, the new issue requires no commendation. For those who have not yet handled it, emphasis may be laid on the words from the title-page: "Compiled from Official Sources." The information provided as to the titles, addresses, officers, and activities of the scientific and learned societies and Government institutions in Great Britain and Ireland has been obtained from officials of the societies concerned, so the volume serves as a directory. In addition, the lists of authors and titles of papers presented before each society during 1925 gives some indication of the amount and direction of progress made in science and the arts. Take, for example, the Royal Society: the total number of papers, 226, shows great activity in the scientific world, while the fact that nearly three-quarters of them were published in Series A of the *Transactions* or *Proceedings* testifies to the fertile field of the mathematical and physical sciences.

The various societies are grouped according to the subjects of their interests, beginning with those dealing with science generally. As regards classification, there will obviously be differences of opinion; we think, however, that the Rontgen Society would be better in the Physics Section than under Chemistry and Photography, while the Spelæological Society (University of Bristol) is certainly archæological rather than biological. The index, however, soon smooths out little difficulties of this kind. The new address of the British Cast Iron Research Association, at 24 St. Paul's Square, Birmingham, was probably announced too late for insertion. We are still of the opinion that all the research associations in Great Britain now in existence should be included and indexed under 'Research.' Some of the more recently formed scientific bodies have not yet appeared in the volume, but meanwhile we must be grateful for the valuable collection of data with which the publishers of this annual continue to supply us.

Elemente der exakten Erblichkeitslehre: mit Grundzügen der biologischen Variationsstatistik. Von Prof. Dr. W. Johannsen. Dritte deutsche, neubearbeitete Auflage in dreissig Vorlesungen. Pp. xi + 736. (Jena: Gustav Fischer, 1926.) 32 gold marks.

THIS well-known book, which was first published in 1909, has now reached its third edition. It is still divided into thirty 'lectures,' but various additions and alterations have been made. More attention is paid to Sheppard's correction for class variants and to Bravais' formula for reckoning the coefficient of correlation. In the latter formula the value of every variant, and not merely that of the classes, enters into the result, and the method can also be used for alternative as well as quantitative variations. The chapters on selection have been extended and those on Mendelism re-written in the light of the more recent work. The word 'gen' is used throughout for the hereditary unit, and Bateson's term 'allelomorph' has been shortened to 'allele,' with a result which would not be very happy if the word were used in English form. In its present form the work will continue to be of great use to geneticists, since it gives in convenient form the various statistical methods used in genetical investigations. But more than this, it is a discussion from the author's characteristic point of view of large fields in experimental genetics.

R. R. G.

Prehistoric Man and the Cambridge Gravels. By the Rev. Frederick Smith. Pp. viii + 121 + 30 plates. (Cambridge: W. Heffer and Sons, Ltd.; London: Simpkin, Marshall and Co., Ltd., 1926.) 7*s.* 6*d.* net.

THE Rev. Frederick Smith, the author of a book on the Stone Ages in North Britain and Ireland, has been engaged in archæological research for more than sixty years. He began to collect from the Cambridge gravels when he was a boy, and he returned to his old hunting-ground in 1924. He has collected many thousands of specimens, and the constant recurrence of certain forms has convinced him that his specimens are implements of various kinds—arrowheads, spear heads, hatchets, knives, and flakers, piercers, and saws—and that certain of them were fitted with shafts. In addition he has found sculptures—a baboon, eagle's beak, an oyster shell, and so forth. The date attributed to them is pre-Chellean, Chellean, and Acheulean. Mr. Smith argues that though the early archæologists were ridiculed and rejected, their views were afterwards accepted, and by analogy claims indulgence for his own views. The argument is as dangerous as its converse. Mr. Smith figures a number of the specimens which he maintains are implements, showing them with and without hafts, but his illustrations still fail to convince.

Handbuch der biologischen Arbeitsmethoden. Herausgegeben von Prof. Dr. Emil Abderhalden. Lieferung 199. Abt. 9: ***Methoden zur Erforschung der Leistungen des tierischen Organismus***, Teil 4, Heft 2. ***Methoden der Erforschung bestimmter Funktionen bei einzelnen Tierarten. Methoden zur Erforschung des Vogelzuges***, von J. Thienemann; ***Methoden zur Behandlung der Atemphysiologie der Insekten***, von Albert Koch; ***Die Verfahren zur Erforschung der Tierfluges***, von Oskar Prochnow. Pp. 123-294. (Berlin und Wien: Urban und Schwarzenberg, 1926.) 7·50 gold marks.

THE first article on the speed and height of the flight of birds is a very brief account of the subject. In the second one, on the respiration of insects (about 80 pages), the function of the spiracles and the movements which ventilate the tracheæ are discussed, and the principal methods for investigating the movements are described and illustrated. Due attention is given to the physical and chemical aspects of the problem, *e.g.* the technique of gas microanalysis. The third article discusses the flight of insects and of birds and the methods which have been employed in the elucidation of the movements and of their mechanics.

Surface Equilibria of Biological and Organic Colloids. By Dr. P. Lecomte du Noüy. (American Chemical Society Monograph Series.) Pp. 212. (New York: The Chemical Catalog Co., Inc., 1926.) 4.50 dollars.

IN the measurement of surface tension the 'ring' method has the great advantage of rapidity, so that variations are readily discovered; and in the hands of the author of this volume it has proved a most useful weapon of research. The book deals largely with the work of the author, but although its scope is therefore not so wide as the title might imply, it is full of interest to the biologist and the physicist. An ingenious method of deducing the three dimensions of the sodium oleate molecule (leading to a value for Avogadro's constant in remarkable agreement with that obtained in very different ways), the size of the albumin molecule and the differentiation of normal and immune serum are among the subjects dealt with in this work, which should prove singularly attractive even to those who are not specialists.

P. C. L. T.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Origin of the Earth's Surface Structure.

In the *Journal and Proceedings of the Asiatic Society of Bengal* (vol. 8, No. 9; 1912) there is a paper by Dr. L. L. Fermor entitled "Preliminary Note on the Origin of Meteorites."

In approaching his subject Dr. Fermor deals with the effects of pressure in determining the mineral constitution of rocks. He refers especially to the case of eclogite, wherein the development of garnet, and occasionally of diamond, is remarkable. The first represents the allocation of the normal elements present in a gabbroid magma in such a manner as to give rise to the development of minerals possessing the maximum density; the second, the same effect in the relatively rare case of carbon being present. He instances the well-known occurrence of both diamond and garnet in certain eclogites of South Africa. Dr. Fermor concludes that there must be what he calls an infra-plutonic zone deep in the earth's surface materials, and probably extending far downwards, composed of rocks of eclogitic type and, probably, at such a temperature as maintains them in a plastic-solid state. He explains the occasional appearance of this infra-plutonic rock at the surface as due to special conditions whereby cooling forestalls the effects of reduction of pressure during the ascension of the rock; which in this way attains a region of negligible pressure while preserving a mineral structure proper to very great depths. The well-known kelyphite rims, sometimes surrounding the garnets of eclogites, indicate a partial break-down into mineral structures of lesser density.

The recent results arrived at by Dr. Harold Jeffreys (NATURE, Sept. 25, 1926), based upon the velocity of transmission of compressional seismic waves, point to the existence of a zone of the density of basaltic glass underlying the granitic continents; the basaltic zone being succeeded downwards by one which Dr. Jeffreys suggests may be dunite. The granitic layer may possess an average thickness of from 20 km. to 30 km. The basaltic zone may have a thickness of about 20 km. The underlying layer may extend to a depth of 1500 km.

Daly has contended for the existence of a general basaltic layer extending beneath the continents and oceans. Other eminent petrologists have held this view. We desire here, in the first place, to cite some recently added evidence in its favour. Washington's discovery of the chemical resemblance of the plateau basalts ejected at various times and at different points of the earth's surface, might in itself be regarded as conclusive. The resemblance, however, seemed to fail respecting the radioactivity of the rocks; the Oregonian basalt showing a much higher radioactivity than the Deccan and Hebridean (*Phil. Mag.*, Nov. 1924). However, we pointed out at the time that the authenticity of our 'Oregonian' material was not perfectly assured. Thanks to the courtesy of Prof. Daly, Prof. Landes, and Prof. W. P. Smith, we have been able to examine specimens of Oregonian basalt of undoubted authenticity, and even a fragment from the specimen chemically investigated by Washington. The average radium and thorium contents of Oregonian rocks from twelve localities come out as closely alike with those already determined for the Deccan and Hebridean areas. Those who are inclined to limit radioactivity to local conditions will find it difficult to explain away the chemical and radioactive similarity of these enormous and widely sundered outpourings.

Coming now to the third terrestrial layer—the high-density medium underlying the basaltic—it appears that there is no necessity, so far as seismic evidence is concerned, to suppose this layer to differ from the basaltic save in the matter of its mineral structure. The gabbros and the eclogites are magmatically the same. We have found that an eclogite possessing the density 3·415 yielded upon fusion a glass which when cold possessed a density of 2·746, which agrees with the results obtained by Day, Sosman, and Hostetter (*Am. Jour. Sci.*, 37, 1914) for the density of basaltic glass. The density of eclogite—the piezocrystalline form of the magma—would agree with the seismic evidence. It ranges from 3·2 to 3·5. That of dunite is 3·3. We see, then, that seismic evidence is not opposed to the simplifying assumption that the sub-continental materials as revealed in the plateau basalts may extend downwards to a depth approximating to 1500 km. In short, the assumption of the eclogitic character of the third terrestrial layer involves little more than the acceptance of Dr. Fermor's inference that the pressure conditions which convert carbon into diamond in eclogites is also responsible for the high-density mineral structure of these rocks.

However, there is something more to be said. We have found recently that the eclogites possess on the average barely one-half the radium and thorium contents of the plateau basalts. An explanation, we believe, can be offered for this apparently contradictory result; an explanation which, if it is correct, seems to throw light on the origin of terrestrial surface structure and surface history.

Yet the explanation we would suggest is very elementary and simple. We assume that the outer material of the primeval earth was originally compounded of all those siliceous aggregates afterwards differentiated into the layers we have been discussing; and that it was not throughout uniform in chemical composition. There was heterogeneity on, probably, a very varied scale; in some places coarse, in others fine: and this heterogeneity of distribution and association affected the stable chemical elements as well as those that are radioactive. These assumptions seem to be the most general we can make as well as the most probable.

Let us consider first the effects of heterogeneity in the distribution of radioactive elements. This would carry with it thermal heterogeneity. Some parts would melt before others, and when their surroundings were melted would retain a higher temperature and lower density. These parts would gravitate upwards. Again, some parts of lesser radioactivity would retain for longer periods the solid state. In the depths this condition would be especially effective, for here the pressure confers upon the medium the maximum density, as we have seen. Thus the temperature and pressure conditions conspire to preserve to, or confer upon, the medium a high density; and accordingly it gravitates downwards when the fusion of its surroundings permits. Hence it would come about that such gabbroid magma as was poor in radioactive elements—poor in uranium, in thorium, and in potassium—would retain the solid state longest and sink into the depths. It is a fact that eclogite is poorer than the plateau basalts in all three radioactive elements. Respecting potassium, the mean content of K_2O in the five plateau basalts analysed by Washington is 0·89 per cent. The mean

K_2O content of seventeen eclogites cited by Rosenbusch is 0·70 per cent., and of eleven cited by Mlle. Brière (*Bull. Soc. Française de Min.*, 43, 1920) it is 0·37 per cent. They are, in fact, at once the poorest in the heat-producing elements and the densest rocks known.

There would, also, exist a lack of homogeneity respecting the distribution of the non-radioactive elements. Some parts would be richer in silica, alumina, etc.; others in metallic oxides, etc.; such parts would for ever seek to ascend or to descend. Or, in times of thermal loss, certain well-known factors concerned in magmatic differentiation would operate in the same directions.

The final results should be precisely what we find; a highly siliceous and aluminous surface layer rich in radioactive elements and—what seismic evidence reveals—in the depths, rocks of maximum density and, as we now find, of minimum radioactivity. Should these inevitable final conditions be disturbed by the circulation attending a great revolution, they would gradually be re-established during the long later period of thermal loss. We perceive, in short, that heterogeneity in the circumstances is not stable, but must result in radioactive and gravitational stratification. Reversing our line of argument, we might justify our assumption of initial heterogeneity in recognition of the revealed surface structure of the earth.

If these views are correct, it would appear that radioactivity mainly has been responsible for the stratification of the earth's outer materials. It has determined the origin of the radioactively rich and gravitationally light continental layer, of the isostatic layer of intermediate radioactivity and density, and of that more deep-seated layer which only at long intervals takes part in the great events of surface history: the major revolutions ("The Halley Lecture," 1924, pp. 31 *et seq.*, and A. Holmes, *Geol. Mag.*, July 1926). In short, it would appear to have fashioned those structural conditions which have been responsible for geological history and for the development of life upon the globe.

Further evidence of stratification in the earth's great basaltic layer is revealed in the petrology of the oceanic islands. The island basalt—which we must regard as representing the same lava as composes the ocean floor or prevails immediately beneath it—is richer in all the radioactive elements, and at the same time lower in density, than are the plateau basalts. These island lavas reveal, in fact, the final differentiation of the substratum where it attains the surface of the globe; a differentiation referable to physical causes similar to those we have referred to above.

As bearing on all our views of earth-history we would point out that the low radioactivity of eclogite directly affects estimates of geological time based upon the period required to bring about a major revolution. The length of previous estimates will require to be doubled.

J. JOLY.
J. H. J. POOLE.

Trinity College, Dublin.

Experiments on highly penetrating Radiation from the Earth.

MEASUREMENTS of penetrating radiation of the earth executed at Piatigorsk (in the Caucasus) by means of a portable electrometer covered with lead 1 cm. thick have shown that, though the same apparatus was used, the intensity fluctuated according to the stations of observation where the measurements were made. The fluctuations of intensity were especially marked in places rich in radium, where differences of so much as 100 per cent. were observed between stations separated by a few metres only.

Measurements made at the same observing stations during a period of three years have shown the intensity to be constant and independent of meteorological conditions, and of fluctuations of emanations contained in the atmosphere, within the limits of sensibility of the apparatus.

Measurements of the prevalence of radioactive elements in the upper layers of the soil have shown its constancy, which indicates that the fluctuations were caused by deeper strata only.

The application of four hoods fitting one into the other, each 2 cm. thick and covering the apparatus from above and laterally, and likewise of four flat lead screens covering it from beneath, has shown the influence of the hoods to be very slight, while that of the screens was quite important, indicating that the electrometer was acted upon chiefly from below.

The thickness of lead protecting the apparatus from above, laterally, and from below, having been varied from 0 to 8 cm., the computation of coefficients of absorption was rendered possible. It appeared that the coefficients of absorption by screens varied from 0·45 to 0·06 for 1 cm. Values approaching the lower limit were frequently encountered at different stations. In most cases the value of the coefficient of absorption diminished with an increase of thickness of the lead screens; that is to say, a complex of radiations was being dealt with, some of them possessing a much greater radiating capacity than the γ-rays of radium C. The radiations are directed from below, and their source lies apparently in radio-elements diffused in upper strata of the soil.

The full report of this work will be published in the *Bulletin of the Institute of Practical Geophysics*, Leningrad.

L. N. BOGOIAVLENSKY.
A. A. LOMAKIN.

Central Chamber of
Weights and Measures,
19 Mejdunarodni Prospect,
Leningrad.

Spectrographic Observations of the Second Green Line of the Auroral Spectrum.

I THINK that all those who have worked on the spectrum of the aurora will congratulate Prof. Vegard on the notable success he has achieved in photographing so distinctly the line or band about λ5238 as recorded in his letter in NATURE of Mar. 5, p. 349. The technical difficulties which he had to overcome were formidable.

The present letter is not written in an unsympathetic spirit, but it seems worth while to point out that an interpretation alternative to that of Prof. Vegard is possible. He identifies the band with one which he has observed in the phosphorescent spectrum of frozen nitrogen. But there is a band in about the same position in the negative band spectrum of gaseous nitrogen. Ångström and Thalén (quoted by Kayser in "Spectroscopie") gave the wave-length as λ5227·5. The stronger bands of the same series come out with great intensity on Prof. Vegard's photograph as on other photographs of the auroral spectrum: so that it is probable, indeed nearly certain, that a long enough exposure would bring out this band.

If, as would appear from Prof. Vegard's letter, precise wave-length comparisons are not feasible, the criterion of intensity distribution remains. I hope Prof. Vegard may think it worth while to photograph this negative nitrogen band with the same instrument, for direct comparison with the auroral spectrum. It is not unlikely that this would help a decision.

RAYLEIGH.

Terling Place, Chelmsford,
Mar. 23.

Is Darwinism Dead?

In Nature of Feb. 19, Sir Arthur Keith brought against me two specific accusations: (1) That I denied in my book "A Companion" (p. 12) the possibility of birds descending from reptiles; (2) that I had given a false reference to Vialleton's high authority. There was a clear issue: (1) Had I said this? (2) Had I misrepresented my authority?

On Mar. 8 I wrote you a brief letter showing that Sir Arthur Keith was ignorant of the great work of Vialleton to which I had alluded, and giving four detailed references. This letter you did not print. In its place you issued, on Mar. 19, a 'comment,' in which you substituted other issues, and repeated as your own the first of Sir Arthur's blunders.

I am therefore compelled to send you this further letter in order that readers of Nature may be acquainted both with the real issue and its upshot.

(1) I made no affirmation upon the descent of birds. What I did say was that a very great authority (Vialleton) had given strong arguments against the reptilian origin of birds with the natural effect of such an authority so reasoning.

(2) So far from giving a false reference, I had worked upon Vialleton's latest and famous work, and in my letter I gave four page references (585, 588, 590, 592) to that work: of which apparently Sir Arthur had no knowledge, or he could not have blundered as he did.

Your comment leaves your readers under a directly wrong impression upon both points. You re-affirm the error of the first; you make no mention of my specific references in the letter, but only say vaguely that I have caught my critic "referring to the wrong book."

My accuracy, and Sir Arthur Keith's lack of that quality on this issue, can be verified as plain matters of fact by any one who will consult the texts in question.

H. Belloc.

Reform Club,
Pall Mall, S.W.1, Mar. 28.

Mr. Belloc is under a triple misapprehension. He believes he gave 'references' in his "Companion"; he did not. He left his readers to guess which Vialleton he had in mind; I guessed the right one, and quoted a pertinent passage from Prof. L. Vialleton's best-known work. If Mr. Belloc had been well advised he would have accepted that quotation without comment, for it is less discordant with modern knowledge than the passages of the later compilation to which Mr. Belloc has directed my attention.

In the second place, Mr. Belloc is under a misapprehension as regards Prof. L. Vialleton's range of original work; that writer has never claimed to be an 'authority' on the evolutionary history of birds, nor is he so regarded by zoologists or palæontologists of any country. I am sure Prof. Vialleton will smile when he learns of the claims which Mr. Belloc now makes for him.

Mr. Belloc's third misapprehension relates to the present state of our knowledge regarding the evolution of birds. The evidence drawn from embryology, geology, and anatomy leaves the expert student in no doubt as to their origin; they arose from a reptilian ancestry.

Arthur Keith.

Royal College of Surgeons, W.C.2.

[No useful scientific purpose would be served by further correspondence upon the points at issue.—Ed. Nature.]

The Atomic Weight of Silver.

The following few lines give a necessary elucidation to my critical note and to the answer given by Messrs. H. B. Baker and H. L. Riley (Nature, Mar. 5, p. 348). My principal first theoretical argument is based on the *interdependence* of the atomic weights of the elements silver, nitrogen, and chlorine, resulting from the classical life-work of Richards and his school, in which I have the greatest confidence. If the atomic weight of silver = 107·876, then nitrogen = 14·006 ± 0·0011, and chlorine = 35·456 ± 0·002, most probably 35·458. If we accept Baker and Riley's value, silver = 107·864, then nitrogen would become 13·999, a value exceedingly improbable, especially having regard to the fact that Baxter found recently (*Proc. Amer. Acad.*, **12**, 12, p. 699, Dec. 1926) by an extremely careful physico-chemical research the value N = 14·006(7), which confirms the higher atomic weight of silver, namely, 107·876. This important argument was not referred to by Messrs. Baker and Riley.

My second, no less important, practical argument was based on the assumption that Messrs. Baker and Riley have lost exceedingly small quantities of silver vapour on fusing the metal in hydrogen, so that the atomic weight found by them is slightly lower than the true one. They did their best to convince themselves that no *visible* condensation of metallic silver could be observed in their tubes, and they say that they have begun a new series of experiments to investigate the volatility and condensability of silver. I beg to remark that some experiments on a large scale in this direction were published by J. S. Stas so long ago as 1865 ("Œuvres complètes," T. I, p. 457), who was my first "atomic weight teacher" in 1875 (but who would read such 'antiquated' papers to-day?). He describes the distillation of 50 gm. of his purest silver in the flame of the oxy-hydrogen blowpipe and says: "Je dois avouer toute fois que, dans les opérations que je viens de décrire, la moitié *au moins* de l'argent employé a été perdue. En effet, il a été entraîné à l'état de vapeur bleue pâle avec le courant de *gas tonnant*, quoiqu'il fût cependant modéré, et sans excès trop grand d'oxygène; il a été répandu dans l'air ambiant dont il a troublé la transparence, et auquel il a communiqué une saveur métallique très sensible."

From this important observation it follows that when silver once passes into the state of vapour it is not easily condensed in a solid state, but forms only a colloidal dispersion as a fog. Large quantities of silver heated in tubes give a condensation of the metal, but when a small quantity was heated and fused, the silver vapour—the weight of which was, in the said experiments, of the order of 0·0001 gm. and which would occupy in the solid state 0·00001 cm.^{3}—may have passed out of the apparatus.

Messrs. Baker and Riley say that they controlled the weight of the fused silver obtained by repeatedly melting and weighing it to constant weight. But the question arises: What was the weight of the silver obtained in a fine state of division immediately after decomposition of its oxide by heat and before fusion? Such silver has a very great surface, and during fusion a small loss by evaporation may have taken place. After fusion, its surface has become very small and, last but not least, it was "coated with a very thin film of dross consisting of silica." To these circumstances the fact is very probably due that no appreciable loss of weight of the silver was observed after repeated fusion.

Bohuslav Brauner.

Bohemian University, Prague, Mar. 10.

Convection of Heat in Fluid Flow through Tubes.

THE convection of heat to or from the walls of a circular tube conveying fluid in turbulent motion has been studied by a long line of investigators, among whom may be mentioned Joule, Reynolds, Stanton, Nüsselt, Soennecken, Jordan, Stender, Heinrich, and Stückle. From dimensional considerations Rayleigh (NATURE, Mar. 18, 1915, p. 66) deduced a formula which, written in non-dimensional form, is equivalent to

$$\frac{ad}{k}=\phi\left(\frac{Vd}{\nu},\ \frac{k}{s\mu}\right), \quad . \quad . \quad . \quad (1)$$

where a = coefficient of transmission of heat.
d = diameter of tube.
V = mean velocity of flow.
k = conductivity of fluid.
μ = viscosity of fluid.
ν = kinematic viscosity of fluid $=\mu/\rho$.
h = diffusivity of fluid $=k/s\rho$.
s = specific heat of fluid.
ρ = density of fluid.

For gases Stanton (Tech. Report Adv. Committee for Aeronautics, 1912–13) gave a formula reducible to

$$\frac{ad}{k}=\text{const.}\left(\frac{Vd}{\nu}\right)^{n}, \quad . \quad . \quad . \quad (2)$$

in which $n=0\cdot75$ approximately for smooth tubes.

Nüsselt (*Z. V. d. I.*, 1909) proposed a formula for gases reducible to his later form:

$$\frac{ad}{k}=\text{const.}\left(\frac{Vd}{h}\right)^{n}, \quad . \quad . \quad . \quad (3)$$

which is equivalent to (2) ($n=0\cdot78$).

Formulæ for water of the form:

$$a \text{ proportional to } V^{n}, \quad . \quad . \quad . \quad (4)$$

have been proposed by Stanton (*Phil. Trans. Roy. Soc.*, 1897), Soennecken (*Forsch.* Heft 108/109), Stender ("Wármeubergang an stromendes Wasser," Springer, 1924), and others. These formulæ do not make explicit mention of the conductivity. Stender finds that the index 'n' depends on an equivalent mean temperature $\tau°$ C. $=0\cdot9Tm+0\cdot1Tw$, where Tm = mean water temperature and Tw wall temperature. Experiments with oil have been carried out by Heinrich and Stückle, but not fully analysed (*Forsch. Arb.* Heft 271).

The object of the present note is to suggest a general formula applicable to all fluids, liquid or gaseous, under conditions of turbulent flow in circular tubes, namely:

$$\frac{ad}{k}=0\cdot0260\left(\frac{Vd}{\nu}\right)^{f\left(\frac{k}{\mu s}\right)}, \quad . \quad . \quad . \quad (5)$$

in which $f(k/\mu s)$ is given approximately by the following values:

$h/\nu=k/\mu s$	0·01	0·10	0·40	1·30
$f(h/\nu)=f(k/\mu s)$	0·97	0·895	0·835	0·785

which lie well on a smooth graph.

This formula agrees well with the experiments of Heinrich and Stückle for oil, those of Stanton, Soennecken and Stender for water ($\tau=10°$ C. to $\tau=70°$ C.). It also agrees as well with the results of Jordan, Nüsselt, Pannel, and others for air, as these agree amongst themselves.

A crucial test of the value of formula (5) would be given by experiments with mercury for which the value of $k/\mu s$ lies outside the range of the experiments referred to above.

A complete formula should take account of the ratio of length to diameter of tube, or else the ratio of initial to final excess temperatures, but (5) is put forward as a step towards the correlation of the results of diverse experiments in which the ratio of length to diameter of tube exceeds about 20.

H. F. P. PURDAY.

70 Bloomfield Road,
Belfast.

The Polishing of Surfaces.

MAY I describe one or two surface-polishing experiments?

1. The first is more easily described than performed. Prepare a polished biprism having a supplementary angle of 4 or 5 seconds. Continue the polishing of one surface. The debris removed will be carried over the edge and deposited in the minute wedged space between the other surface and the tool. When this space is filled, a continuous perfectly polished surface will be produced and only an appearance of interference on the lee side will betray the original biprism character of the specimen. But under the microscope, and by the judicious use of a steel needle, it will be found that the debris is really only compacted; it can gradually be broken away and removed. The underlying surface upon which the debris has been deposited retains its original optical polish.

This seems to indicate that, once a group of molecules has been torn from the embrace of its associates, it is practically impossible under polishing conditions to force it back within the region of molecular cohesion.

2. A thermometer embedded in the polishing tool as nearly as possible in contact with the surface will record a rise of temperature of disappointingly small amount. If polishing is due to actual fusion of the 'hill-tops,' it might be expected in practice that, in view of the multitude of the 'hill-tops' acted upon simultaneously, a considerable rise in temperature might be anticipated. This particular theory seems to be based on the assumption that the small amount of energy involved is transmitted into the glass through an extremely minute area. That the area is never extremely small can be observed by carrying out the operation of polishing under the microscope, the action being viewed through the specimen. Within a second or two the area can be extended from about 2 per cent. to 5 per cent.; in about four minutes the area is about 95 per cent. These results are for a hard pitch polisher. It is remarkable how quickly the pool-like areas spring into view, and an observer will certainly be impressed with the perfection of these areas; there is no appearance of any intermediate stage suggestive of progressive abrasion.

When the whole area is optically polished, can it be contended that the energy is sufficient to maintain in a state of thermol fusion the whole extent of the surface, however thin the layer may be? It is necessary to assume that the load is at any one moment carried by a small number of very minute elements, but the test plate applied to an optically polished surface does not disclose any irregularities sufficiently great to penetrate the film of whatever it may be that exists between the surfaces.

JAMES WEIR FRENCH.

Anniesland, Glasgow, Mar. 19.

The Nodes at the Reduction Division in Bivalents of Hyacinthus.

IN the grasshoppers and some other animals, nodes have been demonstrated in the bivalents, at the late prophase, by Sutton, McClung, Robertson, Wenrich, Janssens, etc. One of the Orthoptera, *Chortophaga* sp., has eleven bivalents and one univalent (X chromosome) at the late prophase of the maturation divisions in the spermatocytes. These are well shown in iron-acetocarmine preparations. The writer found that the six largest bivalents showed 23 cases with one node to 19 with two nodes. The smallest five bivalents had only one node each. At each node it was obvious, as had been previously demonstrated by others, that one chromatid from each homologue seemed to pass to the other side, while the other chromatid remained on the same side.

In *Hyacinthus orientalis*, where there are eight bivalents at the reduction metaphase, the four largest showed one or two nodes, while the four small ones had only one node. Out of 116 examples of the four largest bivalents, 62 had one node and 54 had two nodes. Examination of these nodes showed that one chromatid appeared to pass obliquely across to the other side, while the other chromatid remained on the same side. Also, as in Chortophaga, the planes of the V or ring-shaped portions on different sides of a node were more or less at right angles.

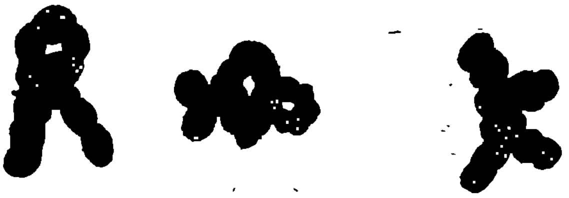

Fig. 1.—Bivalent chromosomes in Hyacinthus.

The best working hypothesis for these cases seems to be segmental interchange between the chromosomes (crossing-over between genes). Crossing-over is known to occur in some monocotyledons, such as Zea. In chromosome I of Drosophila, if we calculate the number of nodes which should be seen in the prophases of the maturation divisions of the ova, to correspond with the determined proportions of no, single, and double crossing-over determined by breeding experiments, we find that the results are not far from those given by Chortophaga and Hyacinthus.

Fig. 1 shows three bivalents of Hyacinthus, the central one having two nodes and the other two one node.

John Belling.

Carnegie Institution of Washington,
Department of Genetics,
Cold Spring Harbor,
Long Island, N.Y.

Magnetic Double Refraction.

The action of a strong magnetic field in causing a liquid to become birefringent for light rays transverse to the field was first observed by Cotton and Mouton in nitrobenzene, and was later detected and measured by the same authors in many other carbon compounds of the aromatic series and in some inorganic liquids (*Annales de Physique*, 28, 209-243; 1913). In a recent paper (C. V. Raman and K. S. Krishnan, *Proc. Roy. Soc.*, A, Jan. 1927) it has been shown that the large value of the Cotton-Mouton constant in aromatic compounds indicates that the benzene ring, which is known from observations on light-scattering to be optically anisotropic, has also a very pronounced magnetic anisotropy. Observations on light-scattering in carbon compounds of the aliphatic series indicate that the molecules of these substances are optically anisotropic to an extent which, though smaller than in the aromatic series, is yet very marked (K. S. Krishnan, *Phil. Mag.*, 50, 697; 1925). It accordingly seemed very probable that the compounds of the aliphatic series should also exhibit magnetic anisotropy and give a measurable double-refraction in strong magnetic fields.

As Cotton and Mouton did not in their papers report any observable magnetic double refraction in carbon compounds of the aliphatic series except in some isolated cases, we decided to make a systematic re-examination of the subject. A large electromagnet capable of giving 25,000 gauss in a column of liquid 32 cm. long was available to us. By securing the most favourable optical conditions and taking careful precautions to eliminate any disturbance from the Faraday effect or suspended colloidal particles, we have succeeded in definitely establishing the existence of magnetic birefringence in every one of the liquids examined, the list including many hydrocarbons, alcohols, ethers, and esters belonging to the aliphatic series. New pole-pieces are now in course of construction for our electromagnet, with which we hope to reach a field of 40,000 gauss in a liquid column of the same length and to make an extended series of quantitative measurements of magnetic birefringence. There is good reason to believe that such measurements will prove of value in elucidating problems of molecular structure.

C. V. Raman.
J. Rama Krishna Rao.

210 Bowbazar Street,
Calcutta, Feb. 15.

An Important Virus Disease of *Lilium longiflorum* and its Varieties.

In the course of work on the diseases of lilies I have shown by means of controlled experiments that an important disease occurring on *Lilium longiflorum* Thunberg and its well-known varieties of commerce, 'Lilium giganteum' (*L. longiflorum* var. *takesima* Duchartre), 'Lilium formosum' (*L. longiflorum* var. *insulare* Hort. apud Mallett), and 'Lilium Harrisii' (*L. longiflorum* var. *eximium* Baker), belongs to the group of filterable virus diseases and is transmitted by the aphid *Aphis lilii* Takahashi (very close to *A. gossypii* Glov.). The identification of the insect was made by Dr. F. V. Theobald.

The symptoms are a marked downward curling and slightly chlorotic appearance of the leaves. Affected bulbs produce only a flattened rosette, hence the name 'yellow flat' given to the disease.

The disease occurs commonly among bulbs of oriental origin. Rigid government inspection has reduced its incidence in the Bermuda lily fields of 'Lilium Harrisii' to a practically negligible quantity.

Details will be published in due course.

Lawrence Ogilvie.
(Plant Pathologist.)

Department of Agriculture,
Bermuda, Feb. 18.

Salaries of University Lecturers.

Prof. H. E. Armstrong's recent reference in Nature (Mar. 19, p. 432) to the salary attached to a lectureship in organic chemistry in the University of Sydney may create misapprehension unless it is pointed out that the general scale for lecturers in all subjects at Sydney is £350, rising by yearly increments of £40 to a maximum of £700 per annum. There is little doubt that the conditions for lecturers at Sydney are distinctly more favourable than those prevailing in many, if not most, of the universities of Great Britain.

John Read.

The University,
St. Andrews.

Lister's Contribution to Preventive Medicine.

By Dr. C. J. Martin, F.R.S.

LISTER was one of the greatest discoverers in the realm of preventive medicine. His direct contribution equalled in usefulness that ever made by one man; for the antiseptic system of treating wounds relieved mankind from most of the danger and suffering attendant upon surgical operations and permitted the art of surgery to advance to unimagined achievements. His indirect contribution was great and far reaching, but is less easy of assessment.

The obliteration of wound infection which followed the successful practice of antisepsis was an enormous stimulus to research into the causation of infectious diseases generally. These researches received every encouragement from Lister, because he, like Pasteur, was convinced that infectious diseases would be found to depend upon the invasion of the body by the lower world of microbes. From 1851, when he was a house surgeon at University College Hospital, his attention had been focussed upon the causation of inflammation, suppuration, fever, and constitutional disturbance, which at that time almost invariably followed surgical operations. That suppuration was not inevitable was clear, because sometimes wounds healed without it, the edges uniting firmly together in a comparatively short time without any bodily illness. After many fruitless attempts to comprehend the process and causation of suppuration, Lister concluded that it would be wise to attack the problem from the beginning and to study the phenomena of inflammation occasioned in the simplest way. To this end he applied hot water and various chemical irritants to a minute portion of the web of a frog's foot and watched under the microscope the effect upon the blood-vessels and surrounding tissues.

Lister's paper on the early stage of inflammation, published in the *Philosophical Transactions* in 1858, is now classical. In it he showed that inflammation was a reaction of the tissues to a noxious stimulus from without. The problem was: When a wound became inflamed, what was the noxious stimulus? This question was ever present in his mind, but no answer was forthcoming, until in 1865 a scientific colleague directed his attention to Pasteur's studies on fermentation and putrefaction. The full significance of Pasteur's observations was immediately apparent to Lister, as his mind was prepared by his previous experimental work. Infection of wounds by germs, and the action upon the tissues of the products produced by them, would supply the cause he was looking for. Were all these untoward phenomena due to the putrefaction of the liquids exuded by the injured tissues? This inference was tested by ingenious experiments and its accuracy was proved, to the lasting benefit of mankind. It should be emphasised that Lister's discovery of the *nature* of wound diseases was one of the great steps in the progress of preventive medicine, and antedated by fifteen years the proof that any particular microbe was indeed the cause of disease.

At this time (1865) the enlightened medical world had grasped that Pasteur's discovery that particular fermentations were produced by specific microbes indicated the possible nature of the various *contagia viva* responsible for disease. It was appreciated that diseases bred true, as dogs and cats bred true, and that they did not arrive *de novo*, although their ultimate origin was as mysterious as the origin of species of higher animals or plants. The real nature of the *contagia* was pure guesswork.

The success of Lister's treatment of wounds was a powerful stimulus to the study of the cause of infectious diseases, but, occupied with the development of his antiseptic system of surgery, he could take little part in these researches. Nevertheless, in the intervals of a busy life, he did find time for bacteriological investigations of a fundamental character.

This new realm of scientific discovery yet lacked appropriate methods, and Lister had to forge his tools as required. He carried out these early researches in his back parlour. Their importance and the ingenuity of the methods he devised are dealt with in their proper perspective by Prof. Bulloch in another article in this week's issue of Nature.

For fifteen years Lister was the principal representative and exponent in Great Britain of the new knowledge, bit by bit unfolded, of the relation of micro-organisms to disease. As his preoccupations increased with his renown, his personal contributions to bacteriological research, perforce, diminished, but the good effect of his encouragement increased.

Whenever the application of bacteriological discoveries to the public health was in question, Lister always took a prominent part. He was president of the Bacteriological Section of the International Congress of Hygiene in 1881, when Koch demonstrated his newly discovered methods of cultivation upon solid media and isolation of different bacteria. In 1890, Koch introduced tuberculin for the treatment of tuberculous infections. Lister, who had a profound respect for Koch, arranged for a thorough trial of the method in his wards at King's College Hospital. Unfortunately, the results, though encouraging at first, proved disappointing.

At the second Tuberculosis Congress in 1901, Lister was in the chair when Koch communicated the results of his experiments upon human and bovine tubercle which had led him to the conclusion that human and bovine tuberculosis were two distinct diseases and that there was no danger for human beings from the consumption of milk or meat from tuberculous cattle. Lister very courteously, but nevertheless trenchantly, criticised Koch's conclusions, pointing out that although the evidence adduced by Koch to show that human tuberculosis could not be communicated to bovines seemed convincing, his reasons for supposing the reciprocal process to be unusual were far less satisfying. In view of Koch's pre-eminence as a bacteriologist and considering the importance of the question, the Congress moved for the appointment of a Royal Commission of inquiry. This suggestion was adopted by the Government. Lister was not a member of the Commission, but he took an active interest in its labours, and when it reported in 1911, it completely justified the criticisms made by him ten years before.

Another enterprise in the interest of preventive medicine which had Lister's sympathy and active support from its inception, was the foundation in England of an institute for the study of the causation and prevention of disease. The origin of the Lister Institute, as it is now called, was as follows. On July 1, 1889, a meeting was held at the Mansion House, London, for the purpose of taking steps to present M. Pasteur with a grateful acknowledgment from Great Britain of his gratuitous kindness in Paris to more than two hundred British patients who had been bitten by rabid animals. The acknowledgment took the form of a donation of £2000 to M. Pasteur for the use of the Institut Pasteur in Paris. At the same time the committee realised the want in the United Kingdom of an institute similar in character and purpose to the Institut Pasteur in Paris, or to the Hygienic Institute in Berlin, and others, established on the Continent for scientific research into the causation and prevention of the various infective diseases of men and animals.

With the idea of meeting this need the British Institute of Preventive Medicine was incorporated on July 25, 1891, and the objects of the Institute were set forth in a Memorandum of Association, namely :

(*a*) To study, investigate, discover, and improve the means of preventing and curing infective diseases of man and animals ; and to provide a place where research may be carried on for the purposes aforesaid.

(*b*) To provide instruction and education in preventive medicine to medical officers of health, medical practitioners, veterinary surgeons, and advanced students.

(*c*) To prepare and to supply to those requiring them such special protective and curative materials as have been already found, or shall in future be found, of value in the prevention and treatment of infective diseases.

(*d*) To treat persons suffering with infective diseases or threatened with them, in buildings of the Institute or elsewhere.

(*e*) With a view to effecting these objects, to provide laboratories, to appoint a scientific staff, to institute lectures and demonstrations, to issue publications of the transactions of the Institute, and to found a library.

Lister succeeded the Lord Mayor as chairman of the committee after its first meeting, and was the first chairman of the council of the British Institute of Preventive Medicine. Among his colleagues were Roscoe, Huxley, Ray Lankester, Burdon Sanderson, Horsley, Cheyne, and Sir Andrew Clark. Lister was a regular attendant at the meetings of the council for many years and took the most active part in the management of the Institute. The office of chairman of the council was for a while no sinecure, and the direction of the new Institute was an anxious task. During its early years it had great financial difficulties to contend with, and on more than one occasion its continued existence was almost despaired of. It was only by means of the enthusiasm and careful guidance of its council and the self-sacrifice of the small body of scientific men which composed its staff that it did not succumb to inanition.

It was also unfortunate in changing its birth name more frequently than is good for a young institution. In 1898 it became the Jenner Institute of Preventive Medicine in order to receive the donation of a sum of money collected to perpetuate the memory of Edward Jenner and his work. Afterwards it was found that a trading firm possessed the prior legal claim to this title, and a further change of designation being necessitated, it was decided to associate the Institute in future with the honoured name of its chairman. It thus, in 1903, became the Lister Institute of Preventive Medicine.

In the meantime the financial stresses which threatened the collapse of the Institute had been considerably relieved by substantial donations from the Berridge Trustees, the Grocers' Company, and a number of public-spirited men. The Duke of Westminster having granted, on terms which meant a large personal contribution, a fine site facing the Thames at Chelsea Gardens, the council proceeded to build one-half of the present headquarters of the Institute. These were opened in 1897.

The permanent income of the Institute was not, however, adequate to the requirements and capabilities of the enlarged establishment, until towards the end of 1898 it received, for the encouragement of research into the cause and treatment of disease, a most generous endowment of a quarter of a million sterling from Lord Iveagh. This endowment enabled the governing body to extend greatly the usefulness of the Institute and to increase the —up to that time—very inadequate staff

The development of serum therapeutics in 1894 attracted general interest in preventive medicine. A few years previously Behring had discovered that by accustoming an animal to small but progressively increasing doses of tetanus poison, the serum of such an animal possessed the property of neutralising considerable quantities of the poison. This discovery was amplified and put to practical use for the treatment of diphtheria by Roux and Ehrlich, and rapidly established itself as the only rational and effective treatment for this disease.

The preparation of antitoxic sera was at once taken up by the Institute. Some temporary premises near London where horses could be accommodated were acquired, and as soon as the value of the remedy was established the council purchased a freehold property near Elstree, Hertfordshire, where a complete equipment for the production of anti-toxic sera and for research into serum therapeutics was installed.

Since then the activities of the Institute have increased considerably, but two of the objects for which the Institute was founded, the education of medical officers of health and the treatment of patients, have been discontinued. Elementary education in bacteriology was soon afterwards adequately provided for by the medical schools, and the prophylactic treatment for hydrophobia, which was the particular treatment in view, was no longer required owing to the freedom of the British Isles from rabies.

The advantages which the Institute enjoyed from its association with Lister were, in the earlier days of its history, by no means confined to his guidance as chairman of its council. To the scientific staff he was always a colleague. Whatever the nature of the problem they were occupied with, they were sure of his sympathy, and his knowledge and critical insight were ever at the disposal of the humblest worker. During the latter years of his life, although no longer able to take an active part in directing its affairs, he did not cease to take a keen interest in the welfare of the institution he had been largely instrumental in founding, and he manifested his confidence in its continued usefulness by making it joint beneficiary with the Royal Society under his will.

Some Aspects of Lister's Scientific Work.

By Prof. William Bulloch, F.R.S.

My qualifications to write on certain aspects of Lister's scientific work rest on an acquaintance with his published writings. I have studied these critically by themselves and in relation to the writings on the same subjects by his contemporaries. For more than ten years I also had the great privilege of knowing Lord Lister in a manner which, considering the great disparity of our positions, I may say was almost intimate. As bacteriologist to the British Institute of Preventive Medicine I had to visit him as chairman almost weekly, to keep him in touch with the progress of the work in the antitoxin department. Even after I left the service of the Institute he frequently asked me to call upon him in connexion with scientific work in which he was interested. In this way I was a great deal in his company and, among the younger men of that time, probably saw more of him than any one else.

When I first knew Lord Lister he was sixty-eight, and I last saw him in 1909 when he was eighty-two years of age. Both then and since he impressed me as a great personality. He was deeply interested in all advances of medical knowledge and, although leading a very busy life, he strove to keep abreast of bacteriological literature, which was then pouring forth in an unbroken stream. I read through with him most of the complicated papers of Ehrlich and Bordet on hæmolysis. During the reading he would make many suggestions or criticisms which might clear up doubtful points. Finished with the work in hand, he would recur to his own work of early days and indicate the difficulties he had had and how he had overcome them. In a conversation we had on Oct. 23, 1905, he said to me—I wrote it down at the time: "If my works are read when I am gone, my papers on the pigmentary changes in the frog and on the early stages of inflammation will be the ones most highly thought of." These were not the mumblings of senility, for he was then intellectually clear and alert. I took it to mean that he wished to be considered as a scientist rather than a surgical craftsman.

In estimating Lister's scientific work it is essential to remember that he had no properly equipped laboratory as we understand the term to-day. There were none such, or but few at the time. His laboratory was his study in his private home, and perhaps the best of his scientific work was that done in 11 Rutland Street, Edinburgh, during his first stay in the northern capital. His principal work on antiseptics was done during the Glasgow period, while his bacteriological work was begun and largely completed in his second Edinburgh period when he resided at 9 Charlotte Square.

The hours for Lister's scientific work were early in the morning and far into the night following a harassing day of active surgical work in private practice, or in the wards, operating theatre, and class-rooms of the Edinburgh Infirmary. He performed all his appointed duties in a most conscientious way, and he undertook his experimental work so that he might speak with first-hand knowledge on the themes which he had to teach. Many of the problems he felt impelled to investigate were obscure and complicated, but of the greatest practical importance. Some were not capable of solution then, and others have not yet been definitively cleared up. I refer in particular to his work on the coagulation of the blood and on the early stages of inflammation.

The coagulation of the blood has at all times excited wonderment, and the theories to explain it have been innumerable and are still being brought to light. In Great Britain notable advances were made in the eighteenth century by William Hewson, who unfortunately died of sepsis from a wound before he was thirty-five. In his short life he made, however, many discoveries. He proved that the red corpuscles were biconcave discs; he described their arrangement in masses like piles of money, an observation extended in 1827 by Lord Lister's father in association with Dr. Thomas Hodgkin. Hewson also clearly noted the existence of the white blood corpuscles and performed a large number of experiments on blood coagulation, although he never quite cleared up the mystery of its nature. His successors in the nineteenth century were not more happy. Coagulation of the blood was early studied by Lister. The problem was constantly before him in connexion with intravascular clotting and the occurrence of putrefaction and secondary hæmorrhage in wounds. The prevailing theory was that of B. W. Richardson, and referred the clotting to the escape of ammonia, which was believed to hold the coagulative elements, normally, in solution.

In a long series of masterly experiments Lister showed that this ammonia theory was untenable. He clearly saw the need of separating the nature of coagulation from the cause, and while baffled with the former he revealed by his experiments that the latter—the cause of coagulation—is really due to the influence exerted on the blood by the contact, even momentarily, of ordinary matter of some kind. He considered that this contact brings about a reaction between the solid and fluid constituents of the blood so that the corpuscles imparted to the *liquor sanguinea* the disposition to clot. As regards the cause of blood coagulation, it cannot be said that we have materially advanced during the seventy years since the publication of Lister's paper.

Another basic pathological process which Lister examined was inflammation. The extraordinary changes which we call inflammation have at all times attracted attention, and the theories intended to explain it constitute a large part of the history of medical doctrines. What is the real nature of the process which we call inflammatory and which results from the application of an *irritamentum* to the body? When Lister began his studies on inflammation, great advances on the older doctrines had already taken place. In England particularly, the science of experimental pathology was in process of rapid growth. The older pathological anatomy so ably created by Morgagni was developed well by the French, among whom the names of Bayle, Portal, Laennec, Bretonneau, Chomel, and Cruveilhier will be brought to mind. Students went from Great Britain to study pathological science in France.

At the beginning of the nineteenth century Edinburgh was a great nursery of medical talent, and many of her graduates migrated across the border to attain fame in the arenas of the south. We all remember with pride the names of Charles Bell, Richard Bright, Thomas Addison, Thomas Hodgkin, C. J. B. Williams, Marshall Hall, William Sharpey, and the peculiarly able if eccentric Wharton Jones. Their work was advanced by the experimental work of Augustus Volnay Waller and of the little-known but successful worker William Addison. Lister had both Sharpey and Wharton Jones for his teachers. The margination of the leucocytes in the inflamed vessels was taught by C. J. B. Williams, and W. Addison about 1842 and Waller (1846) rediscovered the process of emigration of the leucocytes, which had been previously described by Dutrochet in 1827. Wharton Jones summed up in most critical fashion all the work down to 1846, and himself gained the Astley Cooper prize in 1850 for his splendid essay on the phenomena of inflammation.

When, therefore, Lister began to work at the pathology of inflammation he was traversing ground already trodden. He realised, however, that much that had been done concerned the later stages of the process, whereas the real essence of inflammation was most likely to be found by the study of the earliest stages. He worked chiefly with the frog's web and the bat's wing, and took elaborate precautions that at first the parts should be in a perfectly normal condition. By the application of irritants he then passed to the study of what was pathological. Among the phenomena which he particularly investigated may be mentioned the aggregation of the red blood corpuscles, their increased adhesiveness, and the structure of the arterioles and capillaries. He found that the capillaries alter in calibre, but referred the variation to something inherent in their elasticity. While admitting the phenomenon of contractility in the capillaries, modern workers have not accepted his explanation. Lister regarded irritants as acting in a twofold manner. The primary effect was a dilatation of the vessels brought about by the influence of the nervous system and not limited to the *locus* of the irritant. The secondary effect, on the other hand, was the direct result of the irritant acting on the tissues in consequence of which the blood becomes altered physically. The red discs become more adhesive, they accumulate in masses and may bring about the condition of stasis.

Strange to say, Lister made no reference to diapedesis of leucocytes, and probably missed it altogether. Waller's discovery of 1846 had left so little impress at the time that when diapedesis was described in detail in 1867 by Cohnheim, it was regarded as something altogether new. Previous to Lister's work, the advanced changes in inflammation had been observed and very fully described by Wharton Jones, but it is to Lister's credit that he examined it from a new viewpoint and discussed its significance more than his predecessors had done. He was, however, surpassed by Cohnheim in his classical work in 1867.

When Lister embarked on his extended researches on wound complications and the cause of suppuration, his experimental inquiries on blood and inflammation were a great help to him. He was groping unaided for the causes of suppuration, but light was beginning to peer through the darkness. This was early in his Glasgow term. In 1865 his attention was directed by a colleague to the work which had been done on fermentation and putrefaction by Pasteur, and this came to him as a revelation. Almost immediately he grasped the significance of the Frenchman's work for surgery. Ten years later (1875) he specifically tells us that the work of Pasteur "long since made me a convert to the germ theory, and it was on the basis of that theory that I founded the antiseptic treatment of wounds in surgery."

Although Lister constantly stated his indebtedness to Pasteur, it is, I think, a vulgar error to regard him as a mere copyist of his great French contemporary. So early as 1861, and before he knew Pasteur's results, he was getting near the truth about suppuration, and later on he advanced beyond the point where Pasteur had led him. No doubt Pasteur revealed to him in a more concrete form what he had dimly foreseen himself, and from then onwards he was ardent in the pursuit of bacteriology. The time would be the early 'seventies, when the study of microbes had not emerged as a definite science. There were at the time two conflicting views. One of these, supported by Ferdinand Cohn, the botanist of Breslau, held that bacteria, like other plants, had a constancy of form which rendered them capable of division into genera and species. According to the other view, there was no morphological constancy, but rather a pleomorphism, whereby one and the same bacterium could assume different forms. If this were true, attempts to cultivate or to separate them on morphological grounds were doomed to failure.

In his earliest work on the subject in 1873, Lister's observations led him to support the pleomorphic theory, and it will now be admitted that he suffered shipwreck upon it when he stated that Ehrenberg's and Cohn's morphological classification was "entirely untrustworthy." Lister's mistake was one which at the time was made by a great many others and tends to indicate the extraordinary pitfalls which beset the path of the earlier bacteriologists. In his life of Lister, Godlee has published an interesting correspondence which passed between Lister and Pasteur on the subject of change of form among bacteria. Pasteur clearly saw where Lister had erred and advised him to repeat his observations with additional technical precautions. This Lister did, and profiting by his new experience he became one of the foremost bacteriological technicians of his time. So imbued was he with the spirit of high ideals that instead of covering up his tracks he handsomely withdrew his error. "Next to the promulgation of truth," he said, "the best thing I can conceive that a man can do is the recantation of a published error." This sentiment was almost identical with that given to us nearly two thousand years ago by Celsus, who, however, added that such a confession is suited only to a great genius whose splendour is such as to survive the sacrifice, especially in the performance of a task which is to be handed down for the benefit of posterity as a beacon of truth to warn them against similar errors.

From the theory of Cohn and Pasteur it was to be presumed that bacteria might in some way be separated from each other and cultivated in a pure state. The great mycologist, Brefeld, had emphasised the importance of raising such pure strains or cultures from one single germ or cell of a fungus. Following in his wake, Lister was the first to isolate a pure culture of a bacterium. By perfect bacteriological technique involving a complete understanding of the problem, he succeeded in isolating a pure culture of a microbe, *Bacterium lactis*, which is the cause of lactic-acid fermentation in milk. He grew this microbe in sterile milk and raised a pure strain, constant morphologically and physiologically, from a single cell by a series of dilutions carried out with an ingeniously constructed syringe of his own invention. No one can deprive Lister of the merit of having first isolated bacteria in pure culture outside the body. The year was 1877. Lister also introduced the methods of hot-air sterilisation which are in vogue today. His long paper on lactic fermentation is a classic, and a model of what a scientific research should be.

Like Pasteur, Lister had the supreme faculty of seeing as if by instinct the exact experiment needed to clear up a point of doubt. All his scientific work bears witness to this, but I may refer to one other instance of it. In two or three experiments which he did on the fate of catgut implanted in the tissues, he got out all the essential facts in 1869, and later attempts of others in more than three hundred papers down to 1927 have, literally speaking, neither added to nor subtracted from anything which he taught us sixty years ago. He was a master of the experimental method—a rare and precious gift which, the Abbate Spallanzani truly said, "has always been confined and always will be confined to the few."

Obituary.

Prof. Carl Runge.

With the death, on Jan. 3, 1927, of Prof. Carl Runge, of the University of Göttingen, in his seventy-first year, there has passed away an eminent mathematician and a friend to several generations of English-speaking students in Germany.

Runge, whose mother was English, was born in Bremen in 1856 and was educated at Munich and Berlin. In 1886 he was called to the Technical High School at Hanover, where he remained until 1904, when he moved to a professorship at Göttingen in response to an invitation from Klein. Coming in early life under the dominating influence of Weierstrass and Kronecker, it was not unnatural that his first work should be in the field of function theory and algebra, but the urge towards the practical, which directed much of his later work, was soon apparent. Many of his lectures at Columbia University, where he went as an exchange professor in 1909–10, deal with this aspect. At Hanover, as a mathematician in an engineering environment, he had perforce to devise ways and means of adapting methods of mathematical analysis to the practical. Many of his numerical and graphical methods, numerical integration, solution of differential equations and Fourier analysis are now commonplace in engineering training. In this respect his influence on German teaching methods was rather similar to that of Perry in Great Britain. Wherever possible he played an active part in actual practical work, as for example when he assisted in a large geodetic survey, and his appreciation of real problems reflected itself in his teaching and in his theoretical research. His many contributions to the fields of technical mechanics and aerodynamics are evidence of this.

Runge was, however, something more than an engineer, a mathematician, and a teacher. Among experimental physicists he is known for his fundamental work in collaboration with H. Kayser on spectral series, and his work in this field ranks him among those who have laid the experimental basis of quantum mechanics. He examined the spark and flame spectrum of radium. He investigated the magnetic resolution of spectrum lines, and showed that the apparently complex separation may be expressed as simple fractions of that of the normal Zeeman triplet. With Paschen he devised a concave grating mounting that has been adopted in many laboratories. He was pre-eminently one of those all too few men of science who could turn his mind profitably to any field of scientific inquiry with the certainty of producing creative work. Educationally, in Germany his influence was to give a practical orientation to the theorist, and a theoretical outlook to the practical man. To English-speaking students in Göttingen he was undoubtedly the most English of the professoriat, both in appearance and in mental outlook, and he spoke the language fluently. His son was killed early in the War. H. L.

Sir Charles Walston.

We regret to record the death of Sir Charles Walston, the well-known Cambridge archæologist. Charles Walston (formerly Waldstein, the change in spelling having been effected in 1918 at the end of the War) was born in New York of parents of Jewish stock on Mar. 30, 1856. He was educated at Columbia and Heidelberg Universities, and went to Cambridge at the age of twenty-four at the invitation of Henry Bradshaw and Henry Sidgwick as a lecturer in classical archæology.

A brilliant and stimulating teacher, with abundant vitality and unbounded enthusiasm, Walston's qualities as an archæologist and his keen perception of the details of artistic style early won him wide recognition as an authority, and at the same time did much to stimulate the study of ancient sculpture in Cambridge. In 1894 he was elected a fellow of King's College. He held various university posts; among them the readership in classical archæology, the directorship of the Fitz-William Museum, the Slade professorship from 1895 until 1901 and from 1904 until 1911. From 1889 until 1893 he was director of the American School of Archæology at Athens, where he conducted important excavations at Platæa, Eretria, and on the Heraion at Argos (1892–1895). After the expiration of his term as director he retained his professorship at the School until 1896.

Walston's more important publications on archæological and artistic subjects were: "Essays on the Art of Phidias," 1885, "The Work of Ruskin," 1894, "The Study of Art in Universities," 1895; "The Argive Heraion," 1902; "Art in the Nineteenth Century," 1903; "Herculaneum, Past, Present, and Future," 1908; "Greek Sculpture and Modern Art," 1914; and, quite recently, "Alcamenes and the Establishment of the Classical Type in Greek Art," a work of considerable importance and of broad and comprehensive learning, in which he maintained that throughout the early periods up till the fifth century B.C. one facial type, which he called the Minoan, prevailed in Greek art, differing essentially from the classical type. Walston's interests were by no means confined to his special study, and he wrote on a wide variety of subjects of public interest and, during the War, made a number of contributions to the literature of the time, in which he expounded and interpreted national and social tendencies. In this field his most valuable contribution was "Aristodemocracy," published in 1916, while in "Harmonism and Conscious Evolution," 1922, he set out his theory that the æsthetic principle lies at the root of science, morality, and all man's other activities.

Dr. C. Da Fano.

Dr. C. Da Fano, reader in histology, King's College, University of London, died with unexpected suddenness at his residence at Campden Hill on Mar. 14, in his forty-eighth year. By his death medical science in Great Britain loses one of the ablest exponents of histology.

Dr. Da Fano was the third son of Commendatore Alessandro Da Fano. He received his early training in histology in Golgi's Institute of Histology and General Pathology at the University of Pavia, where he graduated M.D. in 1905 and later (1912) became *Libero Docente* in morbid anatomy. He obtained a travelling fellowship at Milan and worked in Ziehen's neurological clinic, University of Berlin, in 1908, and in the following year with Dr. Bashford at the Imperial Cancer Research Fund, London. After a period of work at Groningen he returned to the University of Milan as vice-director of the Pathological Institute. From 1915 until 1918 he served as captain in the Italian medical corps on the Italian front. In 1918 he went to King's College, University of London, as lecturer in histology, and in 1922 was given the title of reader in histology in the University.

Dr. Da Fano specialised in the histology of the central nervous system. His advanced lectures on that subject attracted large audiences, and the histological specimens by which these lectures were illustrated formed a complete and noteworthy collection. His researches, published in a series of about sixty papers in various journals, were mainly concerned with the Golgi apparatus in cells and the special lesions of the nervous system in such affections as encephalitis lethargica. He had a very extensive knowledge of foreign languages, and he generously devoted a considerable portion of his time to acting as one of the editors of *Physiological Abstracts*. In 1915 he married Miss Dorothea Landau, and leaves a son and daughter.

News and Views.

In an article appearing in the supplement to the present issue of Nature, Sir Joseph Larmor gives a novel interpretation of the local space and time of relativity theory as the absolute space and time of Newtonian dynamics and astronomy. This is clearly not the place to attempt a detailed critical analysis of this important paper, but it may be permissible to summarise a few of the salient arguments. The correlation of past and present astronomical research, as well as the absolute character of atoms, evidenced by spectroscopic research, wheresoever and whensoever they are found, demand absolute time. The welding of local frames of inertia into one coherent fourfold is the business of relativity; the mutual dynamics of masses existing in each local frame proceeds independently by Newtonian principles. The mathematical development is effected by means of the Principle of Least Action, modified to suit the requirements of electrodynamics and relativity and limited as to form by the necessity of conforming to the postulate of invariance. The requisite formulation of a compound Action-density is first minimised as regards its distribution with reference to variation of structure of the fourfold pseudospace, giving structural differential equations of that fourfold, and then by partial integration the Action is reduced to line integrals along the tracks of the atoms in the fourfold.

By a further minimising of the Action in its new form, Sir Joseph obtains the expression, suitable to the fourfold, of the dynamical interaction of the atoms. An essential feature is that the track of the atom is not treated as an isolated geodesic, determined by the gravitational warping of the pseudospace, of which it is both partial cause and effect, but is connected with other tracks through mutual terms in their potential energy, which are shared between the interacting atoms. In an earlier paper by Sir Joseph (*Phil. Mag.*, S. 6, vol. 45, p. 243, 1923) this sharing of potential energy led to a reduction of Einstein's gravitational constant to one-half of its usual value, because there the time t of the invariant space-time interval of relativity theory was as usual identified with astronomical time. In the article now under discussion, this untoward result is avoided by identifying the local time T, *i.e.* the invariant time t now corrected for convection by means of the Lorentz transformation, with the absolute time of Newtonian dynamics and astronomy. This procedure leads to Einstein's values of the displacement of spectral lines and of the gravitational deflexion of rays of light, but apparently not to his result for the progressions of planetary perihelia, a conclusion regarded by Sir Joseph as not unsatisfactory in view of the uncertainty of the progression of the perihelion of Mercury, as shown in recent astronomical discussions. Moreover, it leads to the proper relation between electric mass and energy relative to the fourfold, a relation which is not substantiated at all except on the present Newtonian scheme.

April 5 was the centenary of the birth of Lister, physiologist, pathologist, and the 'father of modern surgery,' and elsewhere in this issue Dr. C. J. Martin and Prof. W. Bulloch describe some aspects of his life and work. Celebrations of the centenary commenced in London on April 4, when H.M. The King received delegates from learned societies, universities, and medical societies in Great Britain, from the Dominions and many foreign countries, who are attending the ceremonies arranged by a joint committee of the Royal Society, the Royal Colleges of Physicians and Surgeons, the Royal Society of Medicine, the British Medical Association, and other bodies. Sir Ernest Rutherford, president of the Royal Society, presented an address to the King, to which His Majesty replied, expressing the hope that the gathering of scientific workers for the centenary celebrations would "strengthen the co-operation of all nations in the accumulation of scientific knowledge for the common benefit of the human race." Personal memories of Lister were given by Sir St. Clair Thomson in an address before the Royal Society of Medicine in the evening, and by Sir Watson Cheyne and Sir George Lenthal Cheatle at a meeting in the afternoon of the Listerian Society. On April 5, the official delegates of centenary celebrations were received by the Prime Minister at the house of the British Medical Association, and on the following day a memorial service was held at Westminster Abbey. We hope to give an account of the proceedings in an early issue. Centenary celebrations at Glasgow began on April 1; those arranged at Edinburgh will be held concurrently with the annual meeting there in July of the British Medical Association.

The text has been issued of the Destructive Insects and Pests Bill, which was introduced into the House of Commons by Mr. Guinness on Mar. 25. This Bill provides that an order under the Destructive Insects Act, 1877, as amended by the Act of 1907, may enable an authorised inspector of the Ministry of Agriculture to take necessary action with reference to any crop infected with an insect specified in the order as being a destructive insect within the meaning of the principal Act, which has been introduced into Great Britain. The Act provides that such an inspector may remove or destroy, or cause to be removed or destroyed, any crop infected, or any crop by means of which the insect is likely to be spread. The Bill also provides for the payment of compensation in respect of any crop removed or destroyed. Until now, very few introduced pests have gained a footing in Great Britain, but the provisions under the new Bill are timely precautions. A few years ago the Colorado potato beetle became established in the Bordeaux district of France and its eradication now seems scarcely possible. The entry of such a pest into Great Britain would constitute a menace to a crop that suffers to an almost negligible extent from insect pests. Notwithstanding precautions against their admittance, foreign pests may secure a foothold, and the new Bill provides for the necessary action in the event of such an occurrence. The heavy infestation of cherries from some parts of the continent with the cherry fruit fly is another case in point, but happily that insect likewise has not yet become established in Great Britain.

The first statutory general meeting of the British Mosquito Control Institute was held at the Hotel Cecil, London, on Mar. 30, when the council was elected in accordance with the articles of association approved by the Board of Trade, and by which the Institute is registered under the Companies Acts, 1908–1917, as a company limited by guarantee and not having a share capital. Since the anti-mosquito campaign was begun at Hayling Island about seven years ago, it has become increasingly evident that the work so successfully accomplished there is of more than local interest, and that medical officers of health and sanitary inspectors in many parts of Great Britain, as well as abroad, desire to know how to keep mosquitoes under control. The Ministry of Health can only concern itself with these insects as disease carriers, even though in some districts they make life out of doors almost intolerable in certain months of the year. The Natural History Museum is always willing to identify specimens and give general guidance on methods of dealing with them, but neither it nor the Ministry of Health is concerned with actual field operations by which the mosquito nuisance may be reduced or eliminated. This practical knowledge is, however, available at the British Mosquito Control Institute at Hayling, where there is now a substantial building with laboratory, museum, photographic room, and other facilities for the study of all stages of mosquito life and its regulation. The Institute has been vested in trustees by the founder and director, Mr. J. F. Marshall, whose devoted services in solving problems of mosquito control are widely known and appreciated. Membership is open to all who are interested in the subject, and it is hoped that, in due course, sufficient support will be forthcoming from members and public bodies to make the Institute self-supporting and extend its activities. The council includes among its members Sir Ronald Ross, Sir William Simpson, Sir Arthur Shipley, Dr. Andrew Balfour, Major E. E. Austen, Sir James Crichton-Browne, Dr. G. A. K. Marshall, Dr. C. M. Wenyon, and other entomologists familiar with the mosquito pest, and the chairman is Sir Richard Gregory. The address of the Institute is Hayling Island, Hampshire.

Capt. C. W. R. Knight's kinematograph exhibition "Filming the Golden Eagle" should be seen by every one interested in wild life. It began a short season at the Polytechnic Theatre, Regent Street, W.1, on April 2. By means of this excellent film one is enabled to make intimate acquaintance with one of the finest and least common species in the native avifauna of Great Britain. The pictures were taken last year at three different Scottish eyries, and many interesting incidents from the lives both of the young and of the mother bird are shown. In one case, Capt. Knight was even able to follow the young with his camera for some time after they had left the nest and were able to fly. Perhaps the most striking items are the slow-motion pictures of the adult bird in flight: these include photographs of a trained captive eagle catching the lure in mid-air. In addition to various incidental pictures, there are also some short episodes from the lives of other birds, and those of the chaffinch and of the longtailed-tit are particularly good.

A dispatch from Cairo dated Mar. 31, which appeared in the *Times* of the following day, announces the discovery at Saqqara by Mr. Cecil Firth, working for the Department of Antiquities, of a tomb of the Third Dynasty of about 2900 B.C. The tomb, which has a rounded top, is situated on part of the wall about a mile long which surrounds the Step Pyramid. It is thought that it may be the tomb of Imhotep, the architect of the Step Pyramid. An interesting feature of the tomb is the work of low relief on the doors of the underground rooms. Each represents Pharaoh Zoser in the finest artistic style of the period, and although the figures stand out only a millimetre, each muscle is distinctly shown. Twelve magnificent alabaster jars nearly three feet high were found.

Dr. Gann's preliminary account of his explorations during the past winter in British Honduras, which appeared in the *Morning Post* of Mar. 28 and two succeeding days, again provides material of much interest to the student of Central American archæology, although it contains nothing so sensational as his discovery last year of the early dated stele at Chetumal Bay. An unsuccessful search for a bilingual record, which might play the part of a Central American Rosetta Stone, in the first Spanish church at Villa Real, the settlement founded by Davila in 1528, was followed by a visit to a camp on the lagoon On Ha on the northern boundary, where excavations on burial mounds produced evidence of Toltec influence on the Maya in the form of a clay squatting tiger with a human head protruding from its mouth. Northwest from Sao Xan on the Rio Hondo, Dr. Gann discovered great ruins of a temple structure 120 feet high, of which the roofs must originally have been at least 160 feet from the ground. It contained a single chamber 58 ft. long, 18 ft. high, and only 3 ft. wide. Chambers in other buildings were as narrow, or even less in width. The Maya ignorance of the principle of the true arch and their employment of the method of overlapping stones in roofing restricted the width of their buildings to at most 16 ft., but nothing proportionately so narrow as these chambers is known in Central America. Dr. Gann conjectures that they were constructed for ceremonial purposes.

An exceptional opportunity for the comparative study of folk-dances will be offered by the festival to take place at Bayonne on April 27 and 28. It is being organised by the Musée Basque de Bayonne. A team of fourteen dancers of the English Folk Dance Society will take part in the festival and will give two performances, one at the annual ball in aid of the funds of the Musée, and the second on the afternoon of the following day, when the English dancers will dance in alternation with teams from the Basque provinces of La Soule, Labourde, Basse Navarre, and Guipuzcoa. As some of the dances from these provinces, each of which has its own tradition, are of a very primitive type, yet in certain features present resemblances to some English folk-dances, their presentation at the same performance should be highly instructive. It will be remembered that Miss Violet Alford, both in the paper read before the British Association at Oxford last year and later, in the autumn, at the joint meeting of the Royal Anthropological Institute and the English Folk-Dance Society (Nature, Dec. 4, 1926, p. 824) stressed the significance of the *Danse de l'Ours* of Basse Navarre in relation to the meanings of some of the primitive traits in English dances, and she is now engaged in carrying her researches further in the Pyrenees area. The English Folk Dance Society's party, which will include in addition to the dancers any members of the Society and their friends who wish to avail themselves of this opportunity, will leave for Bayonne on April 24.

Mr. J. Allen Howe delivered the Friday evening discourse at the Royal Institution on April 1, taking as his subject "The Stones of London." Situated on a sub-stratum of clay and incoherent gravel, London, from its very beginnings, has had to go beyond its borders for stone. In the fragments of the Roman Wall we have evidence that its builders sought the slopes of Hertfordshire for boulders of hard sarsen stone, the Downs and the Weald of Kent for chalk, ragstone, chert, and firestone; while the local flint gravel was freely used then as now. The Normans introduced the stone from Caen, of which examples may be seen in the Tower, Westminster Abbey, and other buildings. Beer stone from Devon and the somewhat similar Clunch stone, both from the Chalk formation, were much in demand for carving from about the eleventh century; while for columns, beautifully exemplified in the Temple Church, the marble of Purbeck was the favourite material. From the Great Fire of 1666 a new stone era began for London; although many other stones have been and still are employed, Portland stone from that time began to play a dominant part. The majority of London's buildings are now built or faced with limestone, which is readily attacked by the acid-laden town atmosphere, yielding calcium sulphate in the process; this is in itself a cause of further destruction, as the solution soaks into the stone and there crystallises. In the presence of the acid-bearing air the principal cause of unsightly decay is a state of dampness, which may be conditioned by the aspect, the construction, or the design. Continual efforts are being made to discover a preservative that will not impair the appearance of the stone. The least objectionable of these processes, for example, the various silico-fluorides, are liable to prove ineffective after a comparatively short period, and the latest, Dr. Laurie's silicon-ester, is still on trial. The difficulty with all external applications is imperfect penetration with the consequent danger of skin formation.

The annual lecture to the Graduate Section of the Institution of Mechanical Engineers was given by Sir John E. Thornycroft on Mar. 28, his subject being "Torpedo Boats and their Machinery." It is more than sixty years ago that Sir John I. Thornycroft began steam-boat building at Chiswick, and it was his work and that of Sir Alfred Yarrow which made the Thames famous as the home of the high-speed vessel. There is no more fascinating story in engineering than the history of torpedo craft, from the early boats of 30 tons to the destroyers of to-day of more than 2000 tons. The latter have boilers and turbines of more than 40,000 H.P. giving a speed of nearly 40 knots. Turbines have been fitted for twenty years, but in the four-cylinder triple expansion engines of earlier destroyers mechanical engineering of the nineteenth century reached its highest pitch of excellence. The speed at which they ran, the lightness of their construction, and the conditions under which they worked, were all remarkable. Sir John in his lecture gave comparative figures which showed that the machinery of a liner in 1855 weighed more than 600 pounds per horse-power, while in a modern destroyer the corresponding figure is 30 pounds. In the coastal motor boats built during the War and fitted with internal combustion engines, the weight was only 12¼ pounds per horse-power.

At a meeting of the Newcomen Society on Mar. 30, a paper on "Lead Mining and Smelting in West Yorkshire" was read by Dr. A. Raistrick. In the course of his paper Dr. Raistrick traced the history of lead mining in the Yorkshire dales from Roman times down to the present day, giving notes on the method of quarrying the ore, smelting it, and its sale and transport. Lead pigs are in existence bearing the names of Roman emperors, and there is evidence to show that the industry was carried on continuously, practically down to the present time, though to-day little is being done. The cheaper ores from Spain and elsewhere have been the main cause of the decline, but as foreign mines have to go deeper and instal more machinery, the ore will increase in price and thus the Yorkshire mines may again become profitable. The paper contained much of interest to those who study the history of mining.

Purchases during March for the Department of Zoology of the British Museum (Natural History) included a collection of rare land-snails of the genus Nenia from Peru, Bolivia, etc., and a remarkably fine golden eagle from Norway. The Trustees also purchased, for the Department of Geology, seven specimens of an ancient roofed-head amphibian, Protriton, from a new locality in Thuringia. This little salamander-shaped animal is well preserved in a dark oilshale of Lower Permian age; it is one of the Branchiosauria, which owe their name to the indications of gill-arches in the skeletons of immature individuals. A large collection of skulls and heads of African game animals was presented by Major C. H. B.

Grant. These are particularly valuable since they are accompanied by full details of locality, season, and the like; many of them represent species or races that are now in danger of extermination. Among other donations submitted to the Trustees was a small series of fossil-bearing rocks obtained by the Norwegian expedition of 1921 from the palæozoic formations of Novaya Zemlya. A nodule containing a V-shaped burrow, probably formed by a kind of lob-worm, was presented by Dr. S. H. Haughton, who obtained it from the Upper Dwyka shales of the Warmbad District, South West Africa; it suggests that these rocks were formed on a tidal flat. Mr. J. R. T. Regan presented some curious branching structures, probably worm-tubes, found by him in the Totternhoe Stone near Dunstable. Other donations included nummulites from north-west India described by Major L. M. Davies, and type-specimens of shells from a freshwater sandstone of unknown age in the Fiji Islands collected by Dr. Matley.

The completion of a second submarine cable connecting Canada with Australasia is an event of considerable importance. E. S. Heurtly, in an article in the *Electrician* for April 1, gives many interesting details of the work. It involved the laying of two cables, one between Bamfield, on Vancouver Island, and Fanning Island (3466 sea miles) and between Fanning Island and Suva, Fiji Islands, a distance of 2054 sea miles. The original cable, which was laid in 1902, had a working speed of about 75 letters per minute. By using amplifiers, however, its speed has been increased to about 135 letters per minute. The maximum speed on the new northern cable is at least eight times as great as that of the original cable, and the received voltage at Fanning Island is at least five times as high. The great improvement in the traffic-carrying capacity of the two cables is due to the 'loading' of the cables by alloys of nickel-iron, which have a very high permeability for very low magnetising forces. The 'chrome permalloy' used for loading the southern cable has better electrical characteristics than that used on the New York-Azores cable. The original cable has one advantage over the new cables, as duplex working can be used with it. Owing to the difference in times between Europe and Australasia there is little overlapping of the messages going in opposite directions, and consequently this is not a serious drawback to the new cables. Accurate measurements of the time of propagation of the signals between Bamfield and Fanning Island have been made by means of a siphon recorder used with an amplifier and a tuning-fork. The mean of all the results shows that the signal takes 0·67 of a second to travel 3466 miles. When signalling, therefore, at 1000 letters per minute, more than 40 impulses may be in the cable at the same time.

One of the most remarkable of recently constructed tunnels is the Rove tunnel on the new canal between Arles on the Rhone and the port of Marseilles, by the use of which river traffic can avoid the delta or the crossing of the sea between the terminus of the old canal at Port au Bouc and Marseilles. A fully illustrated article on the canal water appears in *La Science Moderne* for February. The Rove tunnel under the Nerthe hills is nearly four and a half miles long. It has a width of 72 feet, of which 13 feet are utilised by the pathways beside the canal. The depth of water is seven feet and there is room for two streams of canal traffic, with a height above the water line of about 43 feet. Apart from through traffic, this canal promises to be of value in the new scheme, now under way, of making the great Étang de Berre, beyond the northern end of the Rove tunnel, a great port, accessible by large vessels from a wide and deep ship canal at Port au Bouc. Around this extensive harbour is ample room for manufacturing sites. Provided the water power of the Rhone and its tributaries is made available, the port of Marseilles may well become a great centre of manufacturing industry.

The magazine of the Geographical Association, on reaching its fourteenth volume, has been named *Geography* in place of the original title *The Geographical Teacher*. The change in name involves no change in policy or scope. It is still to be published three times a year and to be devoted to the interests of teachers, but its general appearance and production have been much improved. In addition to the usual short articles, notes for teachers, and reviews of geographical books, the spring number contains Sir Charles Close's presidential address on "Population and Emigration," in which he makes a statistical study of Empire settlement. In the belief that the Dominions can absorb annually about five per thousand of their total population, he estimates that Great Britain could send overseas about 100,000 emigrants a year apart from the number that go outside the Empire. He gives a total of about 168,000 as the reasonable annual emigration.

No. 4 of the *Quarterly Review of Biology* completes volume 1, and the editors, Profs. Raymond Pearl and R. W. Hegner, are to be congratulated on the success of their initial volume. The trustworthy and readable articles on subjects of current interest and importance in various fields of biology, and the helpful notices of new biological books, have established the reputation of this new *Review* and have made it what its editors intended it to be—useful to the professional biologist, to the worker in other sciences who wishes to maintain his general interest in biological progress, and to the intelligent lay reader. The principal article in this issue (No. 4) is a comparative account by Dr. Adolph H. Schultz of the fœtal growth of man and other primates, which is excellently illustrated by drawings, diagrams, graphs, and tables. The London agents for the journal are Messrs. Baillière, Tindall and Cox, 7 and 8 Henrietta Street, Covent Garden, London, W.C.2.

Dr. P. Chalmers Mitchell will deliver the annual Huxley Memorial Lecture at the Imperial College of Science and Technology, South Kensington, on May 4, taking as his subject "Logic and Law in Biology."

Sir James Berry, president of the Royal Society of Medicine and author of standard works on surgical subjects; Sir H. Walford Davies, professor of music, University College of Wales, Aberystwyth; and Sir Frederick Keeble, formerly Sherardian professor of botany, University of Oxford, and distinguished by his work in pure and applied botany, have been elected members of the Athenæum Club under Rule II., which provides for election by the Committee of "persons of distinguished eminence in science, literature, or the arts, or for public services."

THE annual dinner of the British Science Guild will be held at the Criterion Restaurant, London, on Thursday, May 12. Lord Askwith will preside, and the guests include Sir Alfred Mond, Sir Herbert Samuel, the Hon. W. Ormsby-Gore, Sir William Pope, and Sir Frederick Keeble. Particulars may be obtained from the Secretary, British Science Guild, 6 John Street, Adelphi, W.C.2.

AT the annual general meeting of the Ray Society held on Mar. 24, the following officers were re-elected: *President*, Prof. W. C. McIntosh; *Treasurer*, Sir Sidney F. Harmer; *Secretary*, Dr. W. T. Calman. Dr. G. P. Bidder was elected a vice-president, and Mr. J. Spedan Lewis and Mr. F. Martin Duncan were elected new members of council. It was announced that the Society's issue for 1927 would be the first volume of a "Monograph of British Sea Anemones," by Dr. T. A. Stephenson, which will be illustrated with coloured plates from the author's drawings of the living animals. It is expected that this work will prove unusually attractive as well as of great scientific interest.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant master for mathematics at the Government High School, Nassau, Bahamas—The Board of Education (C. A. (T.)), Whitehall, S.W.1, or The Scottish Education Department (T.), Whitehall, London, S.W.1 (April 11). An assistant pathologist at the Charing Cross Hospital Institute of Pathology—The Secretary of the Institute, 62 Chandos Street, W.C.2 (April 25). Junior assistants in the aerodynamics department of the National Physical Laboratory—The Director, National Physical Laboratory, Teddington (April 30). A lecturer in geography at Armstrong College—The Registrar, Armstrong College, Newcastle-upon-Tyne (May 7). A professor of agriculture at Armstrong College—The Registrar, Armstrong College, Newcastle-upon-Tyne (May 20). An assistant in the Dominion Museum, Wellington, New Zealand—The High Commissioner for New Zealand, 415 Strand, W.C.2 (May 31). An assistant in the Laboratory of Zoophysiology of the University of Copenhagen, mainly for research work in respiratory metabolism and gas analysis—Prof. A. Krogh, The University, Copenhagen. A teacher of design, with special reference to the textile industry, at the Leicester College of Arts and Crafts—The Registrar. A senior biology mistress at the Cheltenham Ladies' College—The Principal.

Our Astronomical Column.

THE BIELID METEOR SHOWERS.—Mr. Willard J. Fisher, of Harvard Observatory, contributes a paper to *Proc. Nat. Acad. Sciences*, Dec. 1926, in which he collects a large amount of material relating to various apparitions of these showers, and plots them in the endeavour to trace the laws of their recurrence. In 1741 and 1798 the shower occurred on Dec. 6 and 7; there were also December showers in 1830, 1838, and 1847, but all since then have been in November, owing to the motion of the node. On plotting the showers they appear to group themselves along four different lines, indicating presumably that there are several condensations of meteors along the orbit, their periods being slightly different. Many of the brighter showers are separated by intervals of 13·0 years (double the period of the comet). It is noteworthy that three of the four lines in the diagram converge towards a point a few years ahead of the present time, when the date of the shower will be Nov. 16. It will be well, therefore, to keep a careful watch for these meteors in coming years.

COMET GRIGG-SKJELLERUP.—It is curious how this comet has consistently been associated with the British Astronomical Association. It was found both in 1902 and 1922 by members of the Association, Mr. J. Grigg of Thames, New Zealand, and Mr. Skjellerup of Cape Town. The suggestion of identity was first made by Mr. R. T. Crawford and Mr. W. F. Meyer of California, but it was Mr. G. Merton, another member of the Association, who finally proved it, and made a prediction for the return of the present year.

Mr. F. J. Hargreaves, the director of the photographic section of the Association, was the first to photograph the comet at the present return, on two successive evenings, Mar. 27 and 28. It was Mr. Merton who detected the very faint images of the comet, Mr. Hargreaves having overlooked them. Further confirmation was obtained by a photograph taken by Prof. Schorr at Bergedorf on Mar. 31. Mr. Hargreaves uses an aero-lens of 20 inches focus, the mounting being home-made. It is a great encouragement for amateurs that this tiny equipment beat the instruments at the Yerkes and Harvard Observatories, which reported in the same week that they could obtain no trace of the comet. The explanation is that such large, faint, diffused objects are specially adapted to small-scale photographs using a large light-ratio. The deduced date of perihelion is May 10·245, 1927, U.T., which is only one-tenth of a day earlier than Mr. Merton's predicted date, May 10·34. This date had been communicated to Mr. F. E. Seagrave, who published ephemerides based upon it, but without mentioning Mr. Merton's name.

The corrected elements are as follows:

T 1927 May 10·245 U.T.

$$\left.\begin{array}{llll} \omega & 355^\circ & 1' & 48'' \\ \Omega & 215 & 32 & 1 \\ i & 17 & 29 & 18 \end{array}\right\} 1927\cdot0$$

ϕ 43 48 58

log q 9·95068

Period 4·98772 years.

Ephemeris for 0^h U.T.:

	R.A.	Decl.	[log r	log Δ.
Apr. 6.	5^h $58{\cdot}6^m$	1° 25′ S.	0·0123	9·7642
14.	6 11·8	1 17 N.	9·9896	9·7213
22.	6 27·3	4 43	9·9707	9·6676
26.	6 36·1	6 49 N.	9·9633	9·6363

The comet will approach within 19 million miles of the earth early in June. It will probably be a difficult object to observe accurately, being large and diffused.

Research Items.

THE DIVINITY OF THE GUEST.—In the *Ceylon Journal of Science*, vol. 1, Pt. 3, Mr. A. M. Hocart discusses the position of the guest and his relation to his host in ancient Greece, in India, and in Fiji. In ancient Greece no distinction was made between a stranger, a host, and a guest, as they were not distinguishable. Further, not only was the god present with the stranger, and Zeus the patron of strangers, but also he was often regarded either as a god or actually was a god, as is shown in the manner in which Odysseus was addressed in Phaeacia. The exchange of gifts and the return of hospitality, potential or actual, created a bond of hereditary guest friendship out of which grew the consular system in historical times. The idea that the god accompanied strangers was evidently a check on an unhospitable age. In India, in the Atharvaveda the divine character of the guest is worked out in detail, every act of hospitality being identified with some phase of the sacrifice to a god. In the Anguttara Nikaya, the offerings to the Manes include a reception of guests, who are selected either as being learned or virtuous Brahmans, or as being relations through females. In Fiji, various ceremonial observances towards strangers, including the making of gifts, point to their sacred or heavenly character. In Fiji, however, intercourse takes place only through kinsmen, the kinship being either actual or, in case of necessity, fictitious. It is reckoned through the female. There was also a system of official guest friends. It is suggested that the Homeric system may have developed from some such archaic form as the Fijian, India being the common link in which the offerings to kinsmen and guests are distinguished, while in Fiji the recipients are identical; but in both countries divine honours were accorded to guests. The resulting hypothesis is that the divinity of the guest grows out of the divinity of the kinsman, who stands in cross relationship to the host, and this is extended fictitiously to any stranger.

WEAPONS AND ARMOUR OF THE PHILIPPINE ISLANDS.—A description by Mr. Herbert W. Krieger of the collection of primitive weapons and armour of the Philippine Islands in the United States National Museum, which appears as No. 137 of the Museum's *Bulletin*, is of a wider ethnological scope than its title might suggest. The author, in his introductory remarks, deals not only with the history of the collection, which is derived from a variety of sources, and has been given at different times, but also with the development of the types of weapons of the Islands and of their tribal cultures. The various types preserved in metal, bone, wood, and horn, bear traces of the several waves of civilisation that have reached the Philippines. They extend from the primitive digging stick, which may be a club or, with slight adaptations, an axe, a spear, a sword, a knife, or a hoe, down to the cannon of brass and firearms of Spanish manufacture in the possession of insurrectionary native troops. Tribal groups and nationalities manifest in their weapon production and types of body armour and shields a nearness to, or remoteness from, foreign culture influences. No one group has retained exclusively any one type of material culture. Some elements survive from a primitive Melanesian strain; other tribes show borrowings from the aboriginal Negrito: the Batak use the blowgun, a typical Malay weapon, while the Negritos of Zambales and the Luzon east coast use the Malay shield. Fine iron and steel blades, which have come to be recognised as characteristic of the Mohammedanised Moros, show a decorative design on the blade and a blade form invariably of Hindu or Arab character. Although the Spaniards found a crude crucible of stone in use for crushing gold ore and quartz, there appears to have been no stone age in the Philippines. Bamboo furnished in early days all the material required for implements and weapons until those made of iron were introduced from Borneo.

CLASSIFICATION OF HEMIPTERA.—The greater part of Vol. 7 published by the Connecticut State Geological and Natural History Survey, 1923–1925, is occupied by an extensive memoir of more than 800 pages forming Bulletin 34 of the Survey and entitled "The Hemiptera or Sucking Insects of Connecticut." Its author, Dr. W. E. Britton, in collaboration with a number of specialists in different families of the order, has provided a trustworthy and authoritative guide to the classification of Hemiptera, which will be found useful to entomologists in many countries. The bulletin is virtually a text-book on its subject and is well illustrated and provided with a full index.

DISTRIBUTION OF FOOD FISHES IN THE NORTH SEA.—In *Fishery Investigations* (Min. Agric. Fish.) ser. 2, vol. 9, No. 4, 1926, Mr. J. O. Borley provides a series of most instructive charts portraying the quantitative distribution of the marketable sizes of the principal food fishes in the North Sea during the years 1923 and 1924. It should be noted that only fish taken by the trawl are treated; species such as the herring, which are very largely caught in other nets, are dealt with only in so far as they are trawled. The charts are drawn up from the landings of British steam-trawlers, referred to the place of capture. The areas to which landings are referred are small rectangles each 1° of longitude by 30′ of latitude; these vary somewhat in extent with latitude, from 1500 square miles in the southern bight of the North Sea to approximately 1200 square miles in the region of the Shetlands. Each chart depicts a set of contours which indicate the relative frequency of occurrence of one particular trade category of fish, in grades of abundance from less than 1 cwt. to more than 100 cwt. per 100 hours of fishing. A loose key-chart, printed on transparent paper and showing the approximate position and names of some of the chief fishing grounds, is provided, which may be superimposed on the others as desired. The whole work demonstrates very clearly the scientific value of the carefully compiled statistics of commercial landings at British ports. Some notes on the natural history of the fishes dealt with in the charts, prepared by Miss Thursby Pelham from a variety of sources, form a supplement to this publication.

FLEAS AND PLAGUE.—Vol. I., Pt. 4, of the *Ceylon Journal of Science* (Dec. 1926) is devoted to the results of researches by Dr L. Fabian Hirst on the parasitology of plague. He has returned to the important problem of the transmission of plague by the fleas *Xenopsylla cheopis* and *X. astia*. All attempts to transmit plague between rats, mice, and guinea-pigs by means of *X. astia*—596 fleas and a variety of methods were employed—at room temperature in Colombo during four plague seasons gave negative results. Plague was successfully transmitted to twelve rodents by means of 95 *X. cheopis* in the course of six separate experiments at room temperature Plague was successfully transmitted from mouse to rat at an artificially reduced temperature (70° F.) by means of *X. astia*; a female flea of this species with 'blocked' proventriculus transmitted plague to two out of four of the rats on which its bites were observed. Rise of temperature may exert an unequal effect on the transmitting power of two different species of rat-flea. The second part of the work deals with the bionomics of the two species of fleas—egg-laying, life-history, longevity (that of the female being greater), factors which influence biting, etc. A useful list of the rat fleas of the world is given, and appended is a brief account, with seven plates, by Stanley Hirst, of the principal species of Acari parasitic on rats.

POLLINATION EXPERIMENTS WITH PEAS.—More detailed observation of Mendelian ratios is revealing consistent departures from expectation, which have to be explained by differences in the conditions under which the pollen tubes grow down the style of a flower or in the viability and rate of growth of pollen tubes, as well as by reference to other features of flower structure. Dr. C. J. Bond (*Jour. of Genetics*, vol. 17, No. 3) has experimented on these points by pollination of the F_1 hybrids between pea varieties having respectively round yellow and wrinkled green seeds. By pollinating immature stigmas, he finds an increase in the recessives resulting, presumably because the pollen grains bearing the recessive factors, and probably containing more sugar, are more viable or grow faster when the stigma is finally ripe. He also finds a small increase in the proportion of recessives when minimal pollination, *i.e.* only a few pollen grains on the stigma, is used. The explanation of this probably lies in the ovules, as the effect is more marked when the seed-parent carries the recessive characters. Dr. Bond thinks he also gets evidence that the functional ovules in flowers on different parts of the plant bear somewhat different proportions of the dominant and recessive factors. Such results are to be expected with a more detailed knowledge of the physiology of the ovule and pollen development in the plant.

SPONTANEOUS COMBUSTION OF HAYSTACKS.—The losses to agriculture due to the spontaneous combustion of haystacks prove to be considerable. In *Matériaux pour l'étude des calamités* for July-September 1926, Mr. G. Laupper goes into the problem at length and shows from statistics drawn from Switzerland and Germany that such fires are commonest after a good hay season and are least frequent in poor hay years. The monthly incidence also shows a clear maximum in July and August, with high figures for October and November. The summer maximum he associates naturally with the initial high temperature of the hay after its thorough exposure to solar rays before and after being made into ricks, while a good hay season means that the hay is rich in hydrocarbons, the decomposition of which is at the root of the trouble. The yearly loss to agriculture through stack fires in Germany is calculated to be about one million pounds and in Switzerland to be little less. No sure means of prevention have been discovered. Layers of straw or salt in the ricks have been proved valueless, and ventilation is not a certain cure. The only measure that can be recommended is spreading the hay as soon as abnormal temperature is noticed.

THE SURVEY OF INDIA.—The General and Map Publication Reports of the Survey of India for 1925–26 have been published. The total area of new surveys of all kinds completed during the year was 42,489 square miles. About 45 per cent. of the total area assigned to the department has now been surveyed. Work for the new geodetic level net of India made steady progress. Tidal observations were continued as in past years. Map publication included five new sheets of the one-million map of India and adjacent countries, which is now nearing completion except for Arabia; twenty-seven new 'degree' sheets, sixty-nine half-inch and 127 one-inch sheets. The modern topographical map of India thus grows steadily, though only a little more than one-third of the total number of sheets have yet been published. The reports contain full index maps to the sheets available.

SIZE AND FIGURE OF THE EARTH.—Newton's theory of gravitation was held up for several years on account of lack of accurate knowledge of the size of the earth, and Newton himself first estimated the earth's figure from its speed of rotation. The determination of the size and figure of the earth has during the last two centuries exacted enormous labour from geodesists. It is generally assumed that the earth is approximately an ellipsoid of revolution, so that only the equatorial radius and the flattening have to be determined. Observations made in different regions of the globe are, however, rather discordant, the differences amounting to several parts in 100,000 as to the size and about 1 per cent. in the flattening. The labour which the observations have involved is so great that every effort should be made to make the fullest use of them. One difficulty in utilising the separate arcs which have been measured results from the fact that they have been discussed with respect to different figures. The figure of Clarke (1880) suits the European observations well, but a considerably different figure was deduced by Hayford from American observations, and this latter was adopted at the Madrid meeting of the Union of Geodesy and Geophysics as the reference figure for future calculations. To simplify comparisons, particularly with Clarke's spheroid, accurate tables have been computed for the Royal Geographical Society, and by means of these Mr. A. R. Hinks has discussed the principal geodetic surveys. He shows the impossibility of separating the two unknowns from arcs near the equator, and shows that different arcs fit different spheroids, and that those in India and South Africa do not fit any spheroid well. The difference in the results cannot arise from errors in the geodetic observations, but the astronomical observations may be effected to a considerable extent by local attraction, as in India. The probability is, however, that the approximation of the earth to a spheroid is only rough. Mr. Hinks points out that gravity observations can also be treated by a graphical process, and that they likewise indicate departure from a common spheroid when different regions of the earth are considered.

HELIUM CONTENT OF JAPANESE MINERALS.—On heating certain minerals containing helium, approximately 50 per cent. is evolved, and the method has been used by J. Sasaki to determine the helium contents of some Japanese minerals. The gases obtained by heating the powdered substances in an evacuated quartz-glass tube are passed over solid potash, red-hot copper oxide, and soda-lime to remove carbon dioxide and hydrogen. By sparking with oxygen in a eudiometer, nitrogen is converted into nitric oxide, which is absorbed by moist potash floating on the surface of the mercury, and the excess of oxygen is allowed to combine with melted phosphorus. The remaining impurities are removed when the residual gas is subjected to a discharge in a modified Geissler tube with liquid electrodes of a sodium-potassium alloy, and to the action of charcoal cooled in liquid air. Estimates of the geological ages of two of the minerals have been calculated by

Rutherford's method and appear together with the other data in the December issue of the *Bulletin of the Chemical Society of Japan*. The figure for monazite is 90 million years, and that for fergusonite 150 million years.

MAGNETIC ELEMENTS IN THE UNITED STATES.—The United States Coast and Geodetic Survey has recently issued two small pamphlets (Nos. 353, 360, price 10 cents each), one detailing the results of magnetic observations by the Survey during 1925, the other giving a chart, for the whole of the United States, of magnetic declination and its secular change per year, for the epoch 1925. The Survey issues such isogonic charts and secular-change data every five years, suitable stations being reoccupied during the intervening periods, in order to obtain the data necessary to carry the charts forward. With the chart is a full explanation of its construction and use to surveyors, also instructions to enable a surveyor to determine the declination with the aid of a compass and observations of the sun or stars. Tables are given for use in connexion with such celestial observations, and also tables of secular change in declination for a large number of stations, at intervals from 1750 to 1925. The first pamphlet (No. 353) gives observations of declination, dip, and intensity at respectively 330, 123, and 121 stations, widely scattered throughout the States, and including also some in the Philippines, Greenland, and the Aleutian Islands.

INDOOR ELECTRICAL ILLUMINATION.—It was stated by Mr. J. W. T. Walsh, of the National Physical Laboratory, in a paper on illuminating engineering which he read to the Institution of Electrical Engineers on Mar. 3, that 90 per cent. of the people in Great Britain carry on their work after daylight hours by an inadequate illumination and an unsuitable system of lighting. To quadruple the illumination and distribute it properly would result in better health and higher efficiency. The sources of illumination used in the early days cast unpleasant shadows. To get over this defect the indirect system of lighting, in which all the light from the source was reflected upwards to the ceiling and was then diffused over the room, was devised. The result was an almost complete absence of shadow, which, although suitable for a few special purposes, such as drawing-office work, was found to be most inconvenient for other work, such as sewing, where the shadows cast by the individual threads are a help. As a consequence of this defect, the modern semi-indirect system of lighting has been evolved. In this system part of the light is transmitted downwards through a bowl of diffusing material, while the remainder is emitted upwards to the ceiling as in the indirect system. The author considers that each of the three systems has its own field of usefulness. He thinks that in a lecture theatre, the totally indirect system has a tendency to appear lifeless and gloomy even though the amount of the illumination is ample. Some direct sources of light ought therefore to be provided in addition. The reflexion of a bright source of light from a polished surface or from a glossy paint or enamel often causes an objectionable glare. Methods should always be devised to obviate this.

ELECTRICITY SUPPLY.—In the *Journal of the Institution of Electrical Engineers* for March, Mr. J. R. Beard gives a report of the progress made in the transmission and distribution of electricity during the past year. He mentions that for many years the installation of transformer substations out-of-doors has been common abroad, and now, owing to the high cost of buildings, it is becoming common in Great Britain. Until recently all substations for converting from alternating to direct current were manually operated. Owing mainly to the increase in the rates of wages, automatic apparatus for starting up, shutting down, and controlling the apparatus in these stations is now largely used. Experience has shown that automatic control gives greater security than manual control. A recent development is 'supervisory control,' in which the operation of a number of automatic substations can be regulated from a central control point. This combines the accuracy of automatic control with the intelligence of manual control. All the substations on the 170-mile 3000-volt main line electric railway in Natal are operated automatically. Mr. Beard mentions one curious fact in connexion with low-voltage supply in Great Britain and the United States, namely, that while a pressure of about 230 volts is general in the former, a voltage of 115 is used in the latter. The reason seems to be that in the early days the life of the low-voltage lamps was much longer and their efficiency was much higher than that of high-voltage lamps. It is almost the universal custom in America for the supply authorities to supervise and maintain consumers' lamps. In Great Britain this is left to the consumer. Twenty years ago the low-voltage lamps were much cheaper to maintain, and so the over-all efficiency with their use was greater than that with high-voltage lamps. This, combined with the cheaper wiring systems used, explains why 115 volts is still the standard pressure in the United States. Mr. Beard sums up in favour of alternating current distributed in the three-phase four-wire system.

DOPES AND DETONATIONS.—A second communication from the Air Ministry Laboratory by Prof. H. L. Callendar and collaborators, dealing with the effect of antiknock compounds on engine 'knock,' appeared in February issues of *Engineering* (pp. 147, 182, 209). The previous report (Reports and Memoranda, No. 1013) led to the conclusions that detonation was due to the presence of nuclear drops in the charge in the cylinder during explosion, and that 'antiknock' concentrated in the drops, decomposed and protected them from oxidation by the formation of a metallic film or, in the case of the organic dopes, by dilution with a substance of high critical temperature. Such an explanation being inadequate to explain the different behaviour of various dopes, the present communication extends the work on the chemical side. It is found that detonation in paraffin fuels and ether is due to the accumulation of peroxide in the nuclear drops during rapid compression. The amount of peroxide formed would not in itself be sufficient to cause the detonation observed, but acts as a primer causing simultaneous ignition of the drops. The metallic dopes are considered to act by reducing the peroxides as fast as they are formed, preventing their accumulation, and thus delaying the ignition of the drops. The processes of slow combustion of various fuels are investigated by observing the temperature at which combustion becomes appreciable, the dopes being shown in this way to delay oxidation by preventing peroxidation of the fuel. A striking experiment is described, showing the difference in the kind of ignition obtained when the vapour of paraffin is ignited in a hot tube as compared with paraffin spray. In the former case the vapour burns with a quiet flame; in the latter the mixture burns with slight explosions and flashes of flame. The present communication adds to our knowledge of the behaviour of combustible mixtures.

Light and Growth.

THE action of light on plants has had a perennial interest for plant physiologists, and recently the subject has received some concentrated attention. Ferdinand Hercik (*Publications de la Faculté des Sciences de l'Université Masaryk*, No. 74, 1926) has tried to correlate the action of light and the surface tension of the expressed sap of his plants. He finds that the sap of normally grown seedlings of Lupinus, Sinapis, and Pisum has a greater surface tension than sap from stems of etiolated seedlings. On the other hand, sap from leaves of normally grown seedlings has a smaller surface tension than sap from leaves of etiolated seedlings. Now etiolated plants have usually greater stem growth and less leaf growth than normal plants, and the author correlates the greater surface tension with less growth and the smaller surface tension with greater growth. If, however, seedlings have the same length, then the surface tension of their respective saps is the same irrespective of the conditions under which they have been grown. The author has not traced the causal chain between the surface tension of the sap and the actual phenomena of growth.

In a series of papers in the *New Phytologist* (vol. 24, 5, and vol. 25, 3 and 4), Prof. J. H. Priestley deals with the problem from a slightly different viewpoint and advances some tentative explanations of his results. In the case of the broad bean (*Vicia Faba*) he was able to destroy some of the more marked etiolation phenomena by only very brief exposures to light—two minutes in every twenty-four hours. He points out that any change produced on etiolated plants by the action of light must be initiated, not by the effects of photosynthetic products, but by the photocatalytic effect of light upon the products of metabolism. For example, cells from the cortical region of an etiolated broad bean tip are incapable of being plasmolysed in a 17 per cent. cane-sugar solution, but, after exposure to artificial light for one hour on two successive days, are plasmolysed readily. The author considers that the photochemical action of light releases protein and fatty substances from the developing walls of the cells intervening between the central cylinder and meristem; and these walls, now consisting of purer cellulose, readily permit of the transfer of the nutrient sap from the central cylinder, with an ensuing more diffuse and more superficial development of merismatic tissue. In this way growth, which in the etiolated plant is confined to tips of stems, becomes redistributed.

The phototropic curvature of grass and cereal coleoptiles, the subject of much experimentation, is explained by Prof. Priestley on the basis of the foregoing hypothesis. Thus the side of the coleoptile exposed to the light becomes in consequence more permeable, with greater guttation through the apical hydathode from the vein nearer the light. The cells of the lighted side will therefore extend in length less than those of the darkened side, producing a curvature towards the light.

Following still another line of attack, Prof. Y. Yoshi has experimented on the influence of the relative length of day and night on plants (*Science Reports of the Tôhoku Imperial University*, 4th series, vol. 2, 2). His results, in the main, confirm and extend the work of Garner and Allard in grouping plants into two categories, long and short day plants, according to the length of daily illumination necessary for the production of flowers (*Jour. Agri. Res.*, 18, p. 553, and 23, p. 871). The evidence adduced leads to the conclusion that there is probably another group of plants which are nearly or entirely indifferent to photoperiods, but affected by other factors as to time of flowering. The author finds that the optimum photoperiod for reproduction does not result in maximum vegetative growth, and that closely related plants, sometimes even varieties of the same plant, may behave quite differently as regards photoperiods; for example, the late variety of rice plant is a short day plant, while the early variety is indifferent to regulation of light period. This seems to suggest that some other factors besides those concerned in photosynthesis are involved. If the photoperiod is the key to the distinction between spring and winter varieties of wheat, then researches along this particular line may have some application in the practical field of crop production.

Yorkshire Ammonites.[1]

THE amateur geologist who collects Yorkshire ammonites may approach the collection of papers before us with expectation, but he is likely to be disappointed if he hopes to identify his specimens from the descriptions there given. The work is not for the amateur, but for the specialist; and even he will have to dig deep in involved sentences to find the information which only so patient and expert a worker as Dr. Spath can give. These little papers have really an immense scope, gathering up and pronouncing upon outstanding uncertainties in the systematics of the main groups to which belong all ammonites commonly found in the Lower Lias; supplying new generic names where needed; and tilting at the evolutionary conceptions of previous ammonite workers.

To promote the first aim, Dr. Spath appeals to Yorkshire geologists to go into the field and collect Yorkshire ammonites bed by bed. In proposing new generic names, he considers that the quotation of a genotype is sufficient diagnosis. That would be more justifiable if the genotype were a species known by an existing holotype, and not mainly or merely by a figure. It is also probable that ammonite specialists the world over will miss the new genera thus casually proposed in notes on a local fauna in a journal which caters for amateur naturalists rather than professional palæontologists.

The fact is that Dr. Spath has tried to pack into these modest papers matter far beyond their scope, and he has condensed it almost to the limits of intelligibility. We feel that he could expand his remarks on evolution into an enthralling thesis, but here we can catch only the barest outline of his scheme. He has nothing but scorn for those who find comfort in supposed ammonite lineages, but he does not give them instead a clear-cut theory of evolution. The following points, however, seem to stand out: (1) The two great families, namely, Phylloceratidæ and Liparoceratidæ, persisted almost unchanged throughout the Mesozoic, and were the radical stocks whence group after group repeatedly sprang, rapidly evolved in many directions, and quickly died out. (2) Already in Triassic time all possible forms of ornament and whorl-shape had been tried, only to reappear again and again in later stocks (we must not say lineages). This seems to support a doctrine of Trends. (3) Even within a single species the young show very great variability, and on reaching maturity converge to a common form, thus refuting, in Dr. Spath's opinion, the doctrine of post-embryonic recapitulation. (4) New characters often appear first in the young, again proving that the doctrine of post-embryonic recapitulation is unsound. All these evolutionary pronouncements are of great interest, and would bear critical consideration, but here they can only be noticed, not discussed.

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[1] Hull Museum Publications, No. 143 "Notes on Yorkshire Ammonites." By Dr. L. F. Spath Reprinted from the *Naturalist* for April-July, Sept.-Dec., 1925; Feb., May, June, Sept., Nov., 1926.

University and Educational Intelligence.

Bristol.—The following appointments have been made: In the Department of Chemistry, Dr. W. E. Garner, University College, London, to be professor of physical chemistry in succession to Prof. J. W. McBain, and Dr. Morris W. Travers, to be reader in applied physical chemistry and an honorary professor of the University. In the Department of Physics, Dr. J. E. Lennard-Jones, reader in mathematical physics, to be professor of theoretical physics; Dr. H. W. B. Skinner to a Henry Herbert Wills research fellowship in physics. Dr. L. C. Jackson was also appointed to a Henry Herbert Wills research fellowship some time ago.

It is hoped that the building of the Henry Herbert Wills Physics Laboratory will be completed in the summer, and that it will be ready for use by the beginning of next session.

Cambridge.—Field-Marshal Sir William Birdwood has been elected to an honorary fellowship at Peterhouse, a College with which he is closely connected by family ties.

R. O. Redman, St. John's College, has been elected to the Sheepshanks Exhibition in astronomy at Trinity College. The subject for the Adams Prize for the period 1927-28 is announced as "The Variations in the Earth's Magnetic Field in Relation to Electric Phenomena in the Upper Atmosphere and on the Earth." A theoretical contribution to the origin of the various phenomena and their qualitative and quantitative relations with each other is asked for.

London.—The following Doctorates have been conferred: D.Sc. in statistics on Mr. E. C. Rhodes (University College) for a thesis entitled (1) "On a Skew Correlation Surface," (2) "The Precision of Means and Standard Deviations when the Individual Errors are correlated," (3) "The Comparison of Two Sets of Observations"; D.Sc. (Engineering) on Mr. W. H. J. Vernon (Imperial College—Royal School of Mines) for a thesis entitled "The Atmospheric Corrosion of Metals (Second Experimental Report to the Atmospheric Corrosion Research Committee)."

Manchester.—Dr. Alex. M. Smith has been appointed lecturer in agricultural chemistry and adviser under the Ministry of Agriculture advisory scheme.

The Ella Sachs Plotz Foundation has issued its third annual report, from which it appears that thirty-eight applications for assistance in 1926 were received. Thirteen grants were made, seven of them to scientific workers outside the United States. For the present, research on problems in medicine and surgery is favoured, and preference is given to a group of investigations on a single subject; for example, four grants have been given each year for work bearing on the subject of chronic nephritis. Applications for grants for 1927–28 should be sent to Dr. Francis W. Peabody, Boston City Hospital, Boston, Massachusetts, before May 15.

Calendar of Discovery and Invention.

April 10, 1864.—The modern process of manufacturing open hearth steel was started by Pierre-Emile Martin, who melted together pig-iron, scrap, and iron ore in a Siemen's regenerative furnace. Martin's French patent was taken out on April 10, 1864. Two hundred years ago, Réaumur described the conversion of wrought iron into steel by fusing it with pig-iron, but his experiments never went beyond the laboratory stage. The open hearth process was introduced into America in 1868. In 1880 that country produced 1,074,000 tons of Bessemer steel, and 110,000 tons of open hearth steel. Forty years later these figures had increased to 8,883,000 tons of Bessemer steel, and 32,672,000 tons of open hearth steel, the total production being nearly equal to half a ton of steel per head of population.

April 11, 1709.—The most famous of all prizes for scientific work is the Copley Medal of the Royal Society. It was founded by Sir Godfrey Copley, Bart., who by his will dated Oct. 14, 1704, and proved April 11, 1709, bequeathed to Sir Hans Sloane and Abraham Hill "one hundred pounds in trust for the Royal Society of London for improving natural knowledge, to be laid out in experiments or otherwise for the benefit thereof as they shall direct and appoint." No award was made until 1731, when Stephen Gray, an inmate of the Charterhouse, received a prize for his electrical experiments. On Nov. 10, 1736, the Royal Society resolved to convert the bequest into a gold medal, Desaguliers receiving the first, and since then the medal has generally been awarded annually. Copley was a member of Parliament and held various public offices. In 1881 the then representative of the family, Sir Joseph Copley, transferred to the Royal Society a sum in Consols sufficient to provide in perpetuity an annual bonus of £50 to be given to the recipient of the medal (v. also Nature, Dec. 4, 1926, p. 823).

April 13, 1869.—The successful braking of trains was first solved by Westinghouse. A head-on collision between two trains directed his attention to the matter, and the chance reading of an account of the use of compressed air in boring the Mont Cenis Tunnel led to his experiments with an air brake. His first steam-air brake was patented on April 13, 1869. In 1872 he described the automatic brake, and the following year brought out his ingenious triple valve. In the famous trials on trains carried out by Sir Douglas Galton in 1878–9, the brake of Westinghouse proved its superiority, but it was afterwards much improved, Westinghouse alone taking out altogether 103 patents in connexion with it.

April 15, 1777.—A hundred and fifty years ago, in a letter dated April 15, 1777, Volta suggested to Prof. Barletti of Pavia the possibility of firing a pistol at Milan by the discharge of Leyden jars at Como, the two places being joined by an iron wire.

April 15, 1845.—Liebig is regarded as the virtual founder of agricultural chemistry. His famous work, "Die organische Chemie . . ." appeared in 1840, and it was on a barren plot of land outside Giessen that he made his experiments. His researches also led to the foundation of the artificial manure industry, and he himself, through James Muspratt, on April 15, 1845, took out an English patent, the object of his invention being "to restore to the land by means of a manure the mineral elements taken away by the crop which had been grown on and removed from the land."

April 15, 1893.—The finest pre-turbine British liner was the s.s. *Campania*, which on trial on April 15, 1893, developed 31,050 h.p. and attained a speed of 23·18 knots, her displacement being 18,000 tons. E. C. S.

Societies and Academies.

LONDON.

Royal Society, Mar. 31.—**Sir Robert Hadfield**: Alloys of iron and manganese of low carbon content. The range of alloys covers 0·06 per cent. to 38·90 per cent. manganese, also one additional alloy containing 83·50 per cent. manganese. With 4·00 per cent. to 10·00 per cent. manganese the alloys have a comparatively high Brinell hardness, in the region of 400, and are brittle; from 15·00 per cent. to 39·00 per cent. manganese, characteristics are observed similar to those of manganese steel, though only to a limited extent—that is, a comparatively low Brinell hardness, in the neighbourhood of 200, with considerable tenacity and ductility and fair capacity for work-hardening. The alloy containing 83·50 per cent. manganese is hard, brittle, and unforgeable. With 16·00 per cent. or more of manganese the alloys are non-magnetic, whereas in the presence of 1 per cent. of carbon not more than about 7 per cent. manganese is required to take away or suppress the magnetic qualities of the iron. The electrical resistance, while increasing with manganese percentage up to 87·2 microhms per cubic centimetre for the 38·90 per cent. alloy, does so in a fairly continuous manner and without any changes of a critical character such as those observed for the specific magnetism. In their corrodibility the alloys show under some conditions a somewhat improved resistance as compared with ordinary steel, but not such as to make them of any practical value in this connexion. In their micro-structure the alloys with increasing manganese percentage pass at 4 per cent. from a pearlitic structure to a martensitic, which at about 16 per cent., that is, the point where almost completely non-magnetic qualities appear, changes into the austenitic type.

E. Griffiths: The thermal and electrical conductivity of a single crystal of aluminium. A method is described for the determination of the thermal conductivity which does not necessitate any machining of the crystal. Tests were made at various temperatures, the value of the thermal conductivity at 100° C. being 0·55 C.G.S. units. The specific electrical resistivity is $2·89 \times 10^{-6}$ ohms per centimetre cube at 18° C.

W. L. Webster: The transverse magneto-resistance effect in single crystals of iron. The change of resistance of single crystals of iron produced by a transverse magnetic field has been investigated. Measurements were made with the current along a {100}, {110} or {111} crystal axis, and with the field in a series of positions in the plane normal to these directions. The phenomenon is of a double-nature. There is in all cases a gradual decrease in resistance approximately proportional to the field, and probably due to the action of the field on the conducting electrons. Superimposed on this effect there is a sudden change in resistance between 5000 gauss and 12,000 gauss, the sign depending on the direction of the current and the magnitude on the direction of the field. This second effect is probably caused by the change of orientation of the atoms accompanying magnetisation.

W. A. Bone, R. P. Fraser, and F. Witt: The initial stages of gaseous explosions. Part iii. The behaviour of an equimolecular methane-oxygen mixture when fired with sparks of varying intensities. Sparks of varying intensities were passed between electrodes fixed half-way along a horizontal glass tube (35-50 cm. long by 2-2·5 cm. diameter), both ends of which were *closed* in one series of experiments but *open* in another. The new evidence, which mainly lies in the photographs taken, shows (*a*) the occurrence, under ordinary sparking conditions, of what seems to be a definite 'induction period' as a preliminary to the actual combustion; (*b*) initial propagation through the medium of a 'ghost-like flame' condition involving only a very partial combination of the gases; and (*c*) the main combustion, following later as the result of the superposing of a compression wave, or the like, upon a system which during the phase (*b*) has already become highly sensitive to chemical changes.

F. T. Meehan: The expansion of charcoal on sorption of carbon dioxide. Wood charcoal expands when it sorbs carbon dioxide, and the process is reversible. The relations between expansion, pressure and temperature are similar to those connecting quantity of gas sorbed with pressure and temperature. Thus at constant temperature the expansion is related logarithmically to the gas pressure; at constant pressure the expansion is inversely proportional to the temperature. The same relations hold above and below the critical temperature of carbon dioxide. As the expansion is uniform in the three original grain directions, it appears that carbonisation destroys the structure of wood, leaving an isotropic product.

J. E. Lennard-Jones and **W. R. Cook**: The equation of state of a gaseous mixture. A theoretical formula is given for the equation of state of a gaseous mixture, and from it is deduced a generalisation of Dalton's partial pressure law. The forces between the unlike molecules of a mixture can be deduced.

Aristotelian Society, Feb. 21.—**A. Wolf**: Some aspects of the philosophy of Spinoza. The paper dealt with some common misinterpretations of Spinozism. The chief of these are (1) the quasi-Kantian interpretation of the Attributes as subjective ways of regarding Nature, instead of as objective characters of Nature; (2) the mistranslation of *infinite* attributes by *innumerable* attributes, instead of simply "all the Attributes," which may not exceed the two known to man, namely, extension and thought; and (3) the logico-mathematical, instead of the dynamic, interpretation of the attributes in relation to finite objects. The last was specially emphasised, as it obscures the relation of Spinoza to the science of his time and of ours. Reality for Spinoza was essentially activity, energy. Spinoza criticised Descartes' conception of matter as mere extension, saying that from such inert matter the world of physical phenomena could not be derived. For Spinoza matter was essentially energy occupying space. The inert idea of matter had eventually to be abandoned, and, in spite of Newton's protest, matter came to be regarded as kinetic of its own nature, so as not to need an external mover. Similarly with Spinoza's conception of thought; ideas, he insisted, are not dumb pictures on a tablet, but active assertions. While European psychology was for many generations obsessed with the conception of mind as a passive tablet on which sense stimuli make impressions, Spinoza already anticipated present-day dynamic conceptions in psychology, as he anticipated the general kinetic conceptions of physics.

Geological Society, Feb. 23.—**W. D. Lang** and **S. Smith**: A critical revision of the rugose corals described by W. Lonsdale in Murchison's "Silurian System." These forms include some of the earliest-described British Silurian forms. A detailed examination has been made of their external characters and the internal structure with the object of putting the nomenclature upon a sound footing.—**L. G. Anniss**: The geology of the Saltern Cove area (Torbay). The series here termed Red Shale Group (Upper Frasnian and Lower Fammenian) are overthrust on the north by the Staddon Grits and Shales (Upper Coblentzian), and on the south by the 'Massive Limestone' (probably Lower Frasnian). The 'Massive Limestone' forms the high ground on the south and also the summit of Sugar Loaf Hill, between which denudation has cut a deep valley exposing the Upper Devonian as a 'window.' The latter is a series of Red Shales, thin limestones, and tuffs. From these beds goniatites have been collected, which fix the fossiliferous horizon on Zone Iγ of Wedekind. Associated with the Upper Devonian is a decomposed albitedolerite; this rock has no connexion with the intrusions of the Torquay and Dartmouth areas, but is comparable with those of the Ashprington and Totnes areas.

Association of Economic Biologists, Feb. 25.—**F. Tattersfield** and **C. T. Gimingham**: During laboratory and field experiments on contact insecticides, an apparatus and technique have been devised for the quantitative study of the toxicity of contact insecticides, both to adult insects and to insect eggs, and some relationships between chemical constitution and toxicity in certain groups of synthetic organic compounds have been worked out. The results of the laboratory work have led to experiments in the field with certain compounds, highly toxic to insect eggs, which may prove to have practical value for winter spraying. The toxic properties of extracts of some tropical plants have also been studied.

Society of Public Analysts, Mar. 2.—**E. Richards Bolton** (Presidential address). The new preservatives regulations were welcomed. The adulteration of food is steadily decreasing, partly owing to the activity of the authorities, and partly to the efficiency of public analysts. Manufacturers should avail themselves of the services of a chemist to maintain the purity of their products and advise them in order to enable them to avoid any contravention of the law. The food of Great Britain was never in a purer state than it is at the present time.—**A. W. Knapp, J. E. Moss**, and **A. Melley**: Cacao butter substitutes and their detection. The most useful single test is the determination of the 'titre' of the fatty acids, and in the absence of certain other fats (*e.g.* coconut oil) this test enables the amount of Borneo tallow in admixture with cacao butter to be approximately determined after reference to a curve. A new method of determination has been based on the fact that the green colour of Borneo tallow is not bleached by ultra-violet light, whereas the yellow colour of cacao butter is readily bleached.—**H. W. Bywaters, F. T. Maggs**, and **C. J. Pool**: The determination of illipé butter in chocolate. Melted illipé butter becomes turbid at a much higher temperature than cacao butter, and the turbidity temperature determined under definite conditions is practically constant for different specimens of the two fats. If a third fat (*e.g.* milk fat) is also present, the percentage of illipé butter may still be found by reference to a curve, provided that the amount of the third fat can be ascertained.—**A. F. Lerrigo** and **A. L. Williams**: A study of the determination of saccharin, colorimetrically and by the ammonia process (work done under the Analytical Investigation Scheme). None of five colour reactions of saccharin studied under variable conditions gives quantitative results. The ammonia process (in which saccharin is converted into the ammonium salt of sulphobenzoic acid, the ammonia in which is determined by distillation) has been adapted to the determination of small quantities of saccharin.

Linnean Society, Mar. 3.—**A. J. Wilmott**: The Irish Spiranthes called *S. Romanzoffiana* Cham. Specimens from County Cork and Lough Neagh are distinct; the southern one is *S. gemmipara* Lindl., and the northern one *S. stricta* Rydberg.—**J. Davidson**: On the occurrence of intermediates in *Amphis rumicis* L. and their relation to the alate and apterous viviparous females. In *Aphis rumicis* L. (Hemiptera, fam. Aphididæ) both alate and apterous viviparous females (virginoparæ) develop in the parthenogenetic generations. The alate forms tend to produce apterous forms, and the apterous virginoparæ produce only apterous forms or a mixed progeny of apterous and a variable percentage of alate forms. From time to time intermediate individuals develop. Compared with their immediate alate and apterous relations in the same generation, these intermediate forms behaved as apterous forms.

EDINBURGH.

Royal Physical Society, Feb. 21.—**Isobel Deans**: The genus Hicksonia: an account of a new species. A new species, *Hicksonia köllikai*, is described. Attention is directed to the occurrence of telestid-like spicules which suggest the derivation of telestids from clavularids.—**D. Chalmers**: Worm parasites of common marine fishes. The results of an examination of specimens of sixteen species of North Sea fishes. Thirty-one species of parasitic worms are described, including three new, or hitherto unrecorded in the present host.—**C. Cumming**: Re-investigation of the eye of the mole. Embryonic development and histological structure of the eye of the mole are described. The whole of the eye shows a simplification. The lens is degenerate, the retina partly so; normal image perception is impossible.

PARIS.

Academy of Sciences, Feb. 28.—**S. Winogradsky**: Researches on the degradation of cellulose in the soil. Hutchinson and Clayton, in 1919, isolated the first typical representative of the group of aerobic bacteria attacking cellulose, and the author has followed the same general method. A dozen forms have been isolated falling in two groups, Cytophaga, the type discovered by Hutchinson and Clayton, and vibrions. In the latter group, the fibrolytic action is much less marked than with the Cytophaga, but they spread over paper with great rapidity.—**A. Weinstein**: A problem at the limit in an indefinite band.—**Paul Lévy**: The iteration of the exponential function.—**G. Pólya**: The singularities of the lacunar series.—**D. V. Jonesco**: A class of functional equations.—**C. Cerf**: The integration of systems in involution of partial differential equations.—**Mandelbrojt**: A complement to the theorem of M. Fatou.—**G. Sugot**: The integration of the differential equations of the gyroscopic movement of a projectile.—**Kolossoff**: A transformation of the equations of elasticity.—**J. Vorobeitchik**: The horizontal flight of an aeroplane with great radius of action.—**J. Thovert**: The propagation of aerial waves in large subterranean cylindrical mains. The proved lack of uniformity of temperature in large underground mains will tend to give low values for the velocity of sound in such tubes. It would appear to be impossible to apply a suitable correction.—**Belin** and **Holweck**: Television. First results in the transmission of moving images.—**J. Cabannes** and **P. Daure**: The absolute measurement of the intensity of the light diffused by benzene in the liquid state. On the basis of measurements on the light diffused by benzene and other liquids, the authors conclude that it is not at present possible to deduce the Avogadro number from measurements of the diffusion of light by liquids.—**Pierre Jolibois, Henri Lefebvre**, and **Pierre Montagne**: The chemical yield in the decomposition of carbon dioxide under small pressure by the condensed spark. The experimental results cited agree with the theoretical conclusions deduced from the study of the thermal dissociation of carbon dioxide. The energy of the electrical discharge is only partially utilised in the form of chemical energy, and the figures expressing the yield are notably lower than those calculated on the supposition that the spark produces in the gas uniquely a heat development absorbed quantitatively by the gas.—**Albert Kirrmann**: A method of synthesis of α-bromoaldehydes. The general method proposed is the action of phosphorus chlorobromide, PCl_3Br_2 on the acetals $R.CH_2.CH(OR)_2$. This reaction gives the α-bromaldehyde $R.CHBr.CHO$ together with RBr, HBr, phosphorus trichloride and oxychloride. The method is practicable starting from C_4, and gives good yields above C_5. The physical properties of five bromoaldehydes prepared by this method are given.—**Paul Gaubert**: The formation in the insoluble state of two hydrates of magnesium platinocyanide.—**Ch. Gorceix**: The variation of longitudes can be attributed to another cause than the drift of the continents.—**C. E. Brazier**: The periodicity of the magnetic disturbances observed at Parc Saint-Maur and at Val-Joyeux. The results of a statistical analysis of 36 years' observations tend to show that the days on which there are magnetic disturbances succeed each other at intervals of which the approximate duration will be equal to one of the numbers obtained by multiplying the period of synodic rotation of the sunspots by a simple fractional factor, between 0·5 and 3.—**R. Combes**: The nitrogen in a ligneous plant in the course of a year's growth.—**Volmar** and **Samdahl**: The constitution of α-kirondrine. Owing to the small quantity available for study the constitution of α-kirondrine could not be completely determined. It is a bitter toxic principle which is neither an alkaloid nor a glucoside but a lactone containing one or more aldehyde groups.—**A. Demolon** and **G. Barbier**: Study of the mechanism of the exchanges of ions in the clay-lime complex.—**A. Rochon-Duvigneaud** and **M. L. Verrier**: The existence of serous pockets in the orbit and in the eye of the teleosteans.—**Béhague**, **Garsaux**, and **Charles Richet**, jun.: The rhythm and respiratory frequency of animals submitted to a barometric depression.—**Pierre Lesne**: The subfossil Gyrinus of Belle-Isle-en-Mer.—**Armand Dehorne**: The annual reproductive cycle of *Dodecaceria concharum* at Le Portel.—**Louis Bounoure**: The primary gonocytes in the embryos of toads from eggs submitted to uterine super-maturation.—**A. Fernbach**, **M. Schoen**, and **Motohichi Mori**: Some observations on the so-called elective fermentation. It has been held that the differences in the velocity of disappearance of various sugars in a mixture was due to differences in the resistance that the cell-wall of the living yeast offered to the passage of the various sugars. It is now shown that these differences do not depend on the presence of the living yeast, but are also shown by zymines prepared according to the technique of Albert, Buchner, and Rapp. The causes of this selection still remain obscure.—**A. Marxer**: The proteolytic ferment of *Bacillus subtilis*.—**Maurice Letulle** and **Louis Vinay**: Experimental cancer of the lung.

Vienna.

Academy of Sciences, Jan. 27.—**F. Holzl**: The alkylisation of ferrocyanic acid.—**R. Frisch**: The action of slow cathode rays on rock-salt.—**H. Küpper**: Elucidation of morphogenesis and tectonics at the edge of the Vienna basin.—**A. Smekal**: The coloration of rock-salt crystals by radium radiation.

Official Publications Received.

British.

The Preservation of Ancient Cottages. An Appeal by the Rt. Hon. Stanley Baldwin; with a Note by Thomas Hardy. Pp. 16+8 plates. (London: Royal Society of Arts.)

Transactions of the Royal Society of Edinburgh. Vol. 55, Part 1, No 10: On the Feeding Mechanism of a Mysid Crustacean, Hemimysis Lamornae. By Dr. H. Graham Cannon and Miss S. M. Manton. Pp. 219-250+4 plates. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.) 6s.

British Museum (Natural History). Picture Postcards. Set B43: Exotic Butterflies, Series No. 7. 5 cards in colour. 1s. Set B44: Exotic Butterflies, Series No. 8. 5 cards in colour. 1s. (London.)

Shirley Institute Memoirs. Vol. 5, 1926. Pp. viii+340+iv. (Manchester: Shirley Institute.)

Reports of the Progress of Applied Chemistry. Vol. 11, 1926. Pp. 743. (London: Society of Chemical Industry.)

Transactions and Proceedings of the Perthshire Society of Natural Science. Vol. 8, Part 3, 1925-26. Pp. 119-157+xxix-xxxviii. (Perth: Perth Natural History Museum.) 3s. 6d.

Uganda Protectorate: Geological Survey Department. Occasional Paper No. 2: The Geology and Palæontology of the Kaiso Bone-Beds. Part i: Geology, by E. J. Wayland; Part ii: Palæontology, by Members of the British Museum (Natural History) Staff—Mammalia, by Arthur T. Hopwood; Reptilia, by W. E. Swinton; Pisces, by Errol Ivor White; Mollusca, by L. R. Cox. Pp. 71+9 plates+2 maps. (Entebbe.) 6s. 6d.

The Physical Society. Proceedings, Vol. 39, Part 2, February 15. Pp. 99-170. (London: Fleetway Press, Ltd.) 6s. net.

Nigeria. Fifth Annual Bulletin of the Agricultural Department, 1st August, 1926. Pp. 209. 5s. Annual Report on the Agricultural Department for the Year 1925. Pp. 15. (Lagos: Government Printer.)

Department of Agriculture, Ceylon. Bulletin No. 77 (Bulletin No. 43, Rubber Research Scheme, Ceylon): The Inter-Relationship of Yield and the Various Vegetative Characters in Hevea Brasiliensis. By R. A. Taylor. Pp. 67. 40 cents. Bulletin No. 78: Manuring in relation to the Control of the Shot-Hole Borer of Tea (*Xyleborus fornicatus*, Eichh.). Part i by F. P. Jepson; Part ii by Dr. C. H. Gadd. Pp. 49. 40 cents. Bulletin No. 79 (Bulletin No. 44, Rubber Research Scheme, Ceylon): The Construction of Smoke Houses for Small Rubber Estates. By T. H. H. O'Brien. Pp. 7+4 plates. 40 cents. (Peradeniya.)

The Zoological Society of Scotland. An Appeal for Funds for the Scottish Zoological Park. Pp. 40. (Edinburgh.)

Department of Commercial Intelligence and Statistics, India. Agricultural Statistics of India, 1924-25. Vol. 1: Area, Classification of Area, Area under Irrigation, Area under Crops, Live-Stock, Land Revenue Assessment and Harvest Prices in British India. Pp. ii+ix+81. (Calcutta: Government of India Central Publication Branch.) 1.5 rupees; 2s. 3d.

Aeronautical Research Committee: Reports and Memoranda. No. 1046 (Ae. 237): The Effects of Body Interference on Airscrew Performance. By W. G. Jennings. (A. 2.d. Airscrews, 94.—T. 2293.) Pp. 8+3 plates. (London: H.M. Stationery Office.) 6d. net.

The Journal of the Institution of Electrical Engineers. Vol. 65, No. 363, March. Pp. 297-358+xxx. (London: E. and F. N. Spon, Ltd.) 10s. 6d.

The Journal of the Quekett Microscopical Club. Edited by W. S. Warton. Ser. 2, Vol. 15, No. 92, February. Pp. x+211-268. (London: Williams and Norgate, Ltd.) 3s. 6d. net.

Report of the Committee of the Privy Council for Scientific and Industrial Research for the Year 1925-26. (Cmd. 2782.) Pp. iv.+178. (London: H.M. Stationery Office.) 3s. net.

Ministry of Health. Reports on Public Health and Medical Subjects, No. 37: A Report on the Occurrence of Glass Fragments in Foods packed in Glass Containers. By George C. Hancock. Pp. iv+36 (15 plates). (London: H.M. Stationery Office.) 1s. net.

British Research Association for the Woollen and Worsted Industries. Annual Report, 1926. Pp. 23. (Headingley, Leeds.)

Memoirs of the Geological Survey of India. Palæontologia Indica. New Series, Vol. 7, Memoir No. 3: A Review of the Genus Gisortia, with Descriptions of several Species. By E. Vredenburg. Pp. iv+124+32 plates. (Calcutta: Government of India Central Publication Branch.)

Report of the Department of Industries, Madras, for the Year ended 31st March 1926. Pp. iv+93+ii. (Madras: Government Press.) 12 annas.

Forest Bulletin No. 69: The Mechanical and Physical Properties of Himalayan Spruce and Silver Fir. By L. N. Seaman; assisted by C. R. Ranganathan. Pp. iii+26+5 plates. (Calcutta: Government of India Central Publication Branch.) 1.1 rupees; 1s. 9d.

Canada. Department of Mines: Geological Survey. Summary Report, 1925, Part A. (No. 2113.) Pp. 243. Summary Report, 1925, Part B. (No. 2114.) Pp. 46. Economic Geology Series No. 3: The Iron Ores of Canada. Vol. 1: British Columbia and Yukon. By G. A. Young and W. L. Uglow. (No. 2093.) Pp. ii+253. 40 cents. (Ottawa: F. A. Acland.)

Canada. Department of Mines: Victoria Memorial Museum. Museum Bulletin No. 43, Biological Series No. 11: List of Mushrooms and other Fleshy Fungi of the Ottawa District. By W. S. Odell. (No. 2080.) Pp. iii+15. (Ottawa: F. A. Acland.) 10 cents.

University of Reading: The National Institute for Research in Dairying. Annual Report, for the Year ending 31st July 1926. Pp. 62. (Reading.)

Report on the Health of the Army for the Year 1925. (Vol. 61.) Pp. iv+152. (London: H.M. Stationery Office.) 3s. 6d. net.

The Institution of Professional Civil Servants. Annual Report of Council for the Year 1926. Pp. 44. (London.)

Report of the Marlborough College Natural History Society for the Year ending Christmas, 1926. (No. 75.) Pp. 91. (Marlborough.) 5s.

Torquay Natural History Society. Transactions and Proceedings for the Year 1925-6. Edited by the Rev. James H. Balleine and H. L. Earl. Vol. 4, Part 4. Pp. 289-336. (Torquay.)

Report of the Rugby School Natural History Society for the Year 1926. Pp. 64. (Rugby.)

Journal of the Marine Biological Association of the United Kingdom New Series, Vol. 14, No. 3, March Pp. 557-836. (Plymouth.) 10*s*. net.

The Newcomen Society for the Study of the History of Engineering and Technology. Transactions, Vol 5, 1924-1925. Pp. xii+139+22 plates (London: Science Museum.) 20*s*.

Foreign.

The Carnegie Foundation for the Advancement of Teaching Bulletin No. 18: Games and Sports in British Schools and Universities By Howard J. Savage Pp. vii+252 (New York City.)

Proceedings of the Imperial Academy. Vol. 3, No. 1, January. Pp. ii+48 (Ueno Park, Tokyo.)

Agricultural Experiment Station, Michigan State College of Agriculture and Applied Science. Special Bulletin No. 161: Varieties and Locations as Factors in Apple Production. By V. R. Gardner. Pp. 45 Circular Bulletin No. 98 How to Make and Preserve Cider. By F. W. Fabian. Pp. 20 Circular Bulletin No. 99. House Plants. By Alex Laurie. Pp. 18. Circular Bulletin No 100: Michigan Farmers' Tax Guide. By R Wayne Newton. Pp 11. (East Lansing, Mich.)

University of Illinois Engineering Experiment Station. Bulletin No. 158: The Measurement of Air Quantities and Energy Losses in Mine Entries. By Prof Alfred C Callen and Cloyde M Smith Pp 77. 45 cents. Bulletin No. 159 An Investigation of Twist Drills. By Bruce W. Benedict and Albert H. Hershey. Pp 76. 40 cents (Urbana, Ill)

Smithsonian Institution. United States National Museum Contributions from the United States National Herbarium. Vol 22, Part 10: The North American Species of Scutellaria. By Emery C. Leonard. Pp viii+703-748. (Washington, D C. Government Printing Office)

Smithsonian Institution. United States National Museum Bulletin 138. The Fossil Stalk-Eyed Crustacea of the Pacific Slope of North America. By Mary J. Rathbun Pp viii+155+39 plates. 50 cents. Bulletin 139: Fire as an Agent in Human Culture. By Walter Hough. Pp xiv+270+41 plates. 50 cents. (Washington, D.C. Government Printing Office.)

Department of the Interior: U.S. Geological Survey. Bulletin 784: Bibliography of North American Geology for 1923-1924. By John M. Nickles. Pp iii+280 40 cents. Bulletin 788-B: Topographic Instructions of the United States Geological Survey. B: Triangulation. Compiled by E. M Douglas. Pp. ii+47-87+4 plates. 10 cents. Bulletin 788-C. Topographic Instructions of the United States Geological Survey C: Transit Traverse. Compiled by E. M. Douglas. Pp. iv+89-116+3 plates. 10 cents. Bulletin 788-D. Topographic Instructions of the United States Geological Survey. D. Leveling Compiled by E. M. Douglas. Pp. iv+117-160+2 plates. Bulletin 790-A: Pedestal Rocks formed by Differential Erosion and Channel Erosion of the Rio Salado, Socorro County, New Mexico. Papers by Kirk Bryan. (Contributions to the Geography of the United States, 1926.) Pp. ii+19+8 plates. (Washington, D.C. Government Printing Office.)

Department of the Interior: U.S. Geological Survey. Water-Supply Paper 568: Surface Water Supply of the United States, 1922. Part 12: North Pacific Slope Drainage Basins. B: Snake River Basin. Pp. vi+295+2 plates. 40 cents Water-Supply Paper 554. Surface Water Supply of the United States, 1921. Part 12. North Pacific Slope Drainage Basins C Lower Columbia River Basin and Pacific Slope Drainage Basins in Oregon. Pp. v+186+2 plates. 25 cents. Water-Supply Paper 559 Relations between Quality of Water and Industrial Development in the United States. By W. D. Collins. Pp iv+43+5 plates. 15 cents. Water-Supply Paper 565. Surface Water Supply of the United States, 1922. Part 5. Hudson Bay and Upper Mississippi River Basins. Pp. v+190+8 plates. 30 cents. Water-Supply Paper 580-B Water Power and Irrigation in the Jefferson River Basin, Montana. By John F. Deeds and Walter N. White. (Contributions to the Hydrology of the United States, 1926) Pp ii+41-116+1 plate. (Washington, D.C.: Government Printing Office)

Department of the Interior: U.S. Geological Survey. Forty-seventh Annual Report of the Director of the Geological Survey to the Secretary of the Interior for the Fiscal Year ended June 30, 1926. Pp. ii+96 (Washington, D.C. Government Printing Office)

Meddelanden från Lunds Astronomiska Observatorium. Serie 2, Band 5, No. 41-50: Festskrift tillägnad C. V. L. Charlier på hans Sextiofemårsdag den 1 April 1927 av Lärjungar. Pp. 20+15+86+16+13+25+60+8+9+97+17+23+8+20+12 No 84 Studies in Stellar Statistics. v: On the Galaxy of the B-Stars. By C. V. L. Charlier Pp 33+10 plates. No 85: On the Calculation of the Characteristics of the Apparent Proper Motion Distribution of the Stars By W Gyllenberg Pp. 12 No. 86 Statistical Notes on the Draper Catalogue By C. V. L. Charlier. Pp. 36+28 plates. No. 112 Einige Bemerkungen über die räumliche Verteilung der Sterne. Von K. G. Malmquist Pp 7 No 113. On the Zero Point of the Period-Luminosity Curve. By K. G. Malmquist Pp 7 (Lund: C. W. K. Gleerup)

U.S. Department of Agriculture. Department Bulletin No. 1439. Fish Oil, an Efficient Adhesive in Arsenate-of-Lead Sprays. By Clifford H. Hood Pp 22 10 cents. Department Bulletin No. 1476: A Progress Report on the Investigations of the European Corn Borer By D. J Caffrey and L H Worthley Pp. 155. 25 cents. (Washington, D.C.: Government Printing Office)

University of Washington Publications in Anthropology Vol. 1, No. 5: Klallam Ethnography By Erna Gunther. Pp 171-314 (Seattle, Wash.: University of Washington Press) 1.25 dollars

New York Academy of Sciences. Scientific Survey of Porto Rico and the Virgin Islands. Vol. 7, Part 1. Plant Ecology of Porto Rico. By H. A. Gleason and Mel. T. Cook. Pp. 96+20 plates 2 dollars. Vol. 7, Part 2: Plant Ecology of Porto Rico By H. A. Gleason and Mel. T. Cook. Pp. 97-173+plates 21-50 2 dollars. (New York City.)

Proceedings of the United States National Museum. Vol 70, Art. 19: Diagnoses of Undescribed New Species of Mollusks in the Collection of the United States National Museum. By William Healey Dall (No. 2668) Pp. 11 Vol 70, Art. 21: A Stony Meteorite from Forksville, Mecklenburg County, Virginia By George P. Merrill (No 2670) Pp 4+3 plates. (Washington, D.C.: Government Printing Office.)

Contributions from the Jefferson Physical Laboratory and from the Cruft High-Tension Electrical Laboratory of Harvard University for the year 1925 Vol 18. 48 papers, not paged (Cambridge, Mass.)

Diary of Societies.

SATURDAY, April 9.

Royal Institution of Great Britain, at 3.—Sir Ernest Rutherford: The Alpha Rays and their Application to Atomic Structure (4)

MONDAY, April 11.

Royal Irish Academy, at 4.15.

Royal Society of Medicine (War Section) (Annual General Meeting), at 4.30.—Major T. J. Mitchell. Man-power and the Medical Service in Relation to some of the Principles of War.

Royal College of Surgeons of England, at 5.—C. E. Shattock: Demonstration of Joints.

Institution of Electrical Engineers (Informal Meeting), at 7.—T. Hodge and others. Discussion on The Maintenance of Small Electric Power Plants.

Institution of Electrical Engineers (North-Eastern Centre) (at Literary and Philosophical Society, Newcastle-upon-Tyne), at 7.—Dr. A. Ekstrom. The Applications of Electricity to Agriculture.

Institution of Electrical Engineers (Western Centre) (at South Wales Institute of Engineers, Cardiff), at 7.—J. R. Beard and T. G. N. Haldane: The Design of City Distribution Systems, and the Problem of Standardisation

Ceramic Society (at North Staffordshire Technical College, Stoke-on-Trent), at 7.30.—Annual Meeting.

Railway Club (at 25 Tothill Street, S.W.1), at 7.30.—J. F. Gairns: The Importance of Secondary Train Services.

Royal Institute of British Architects, at 8.—Prof. P. Abercrombie: The Planning of East Kent.

Royal Society of Medicine (Odontology Section), at 8.—Prof. Gottlieb: Diseases of the Gingival Margin.

Surveyors' Institution, at 8.—G. Turville Brown: The Sugar Beet Industry in Great Britain.

TUESDAY, April 12.

Society for the Study of Inebriety (at Medical Society of London), at 4.—Dr. R. W. Branthwaite and others. Discussion on The Inebriates Act of 1898

Royal Society of Medicine, at 5.30.—General Meeting

Institution of Petroleum Technologists (at Royal Society of Arts), at 5.30.—E. H. Cunningham-Craig: Jet and Jetonised Material.

Institute of Marine Engineers, at 6.30.—T. Clarkson: The Recovery and Utilisation of Heat from the Exhaust Gases of Internal Combustion Marine Engines.

London Natural History Society (at Winchester House, E.C.), at 6.30.—J. A. Simes: Butterfly Hunting in Central and Southern Europe (Bacot Memorial Meeting).

Royal Photographic Society of Great Britain, at 7.—H. J. Bedford: Big Fleas and Little Fleas; or Notes from a Nature Photographer's Diary.

Institute of British Foundrymen (Lancashire Branch, Burnley Section) (at Municipal College, Burnley), at 7.15.—Annual General Meeting.

Institution of Engineers and Shipbuilders in Scotland (at 39 Elmbank Crescent, Glasgow), at 7.30.—J. G. Worker: Latest Developments in Underfeed Stoker Practice in the United States.

North-East Coast Institution of Engineers and Shipbuilders (Middlesbrough Branch) (at Cleveland Scientific and Technical Institution, Middlesbrough), at 7.30.—W. C. Freeman: The Production and Modern Applications of Dissolved Acetylene.

Quekett Microscopical Club, at 7.30.—Prof. R. R. Gates: A Naturalist on the Amazon.

Institution of Electrical Engineers (Scottish Centre) (at Royal Technical College, Glasgow), at 7.30.—S. Mavor: The Applications of Machinery at the Coal Face.

WEDNESDAY, April 13.

Eugenics Society (at Royal Society), at 8.30.—Dr. J. W. Heslop Harrison: Induced Mutations and their Importance for Evolution

THURSDAY, April 14.

South London Entomological and Natural History Society, at 7.

PUBLIC LECTURE.

SUNDAY, April 10.

Guildhouse (Eccleston Square), at 3.30.—Rev. Father Andrew: Christianity

CONFERENCES.

April 11 to 13

French Association des Anatomistes (jointly with the Anatomical Society of Great Britain and Ireland) (at University College).

April 20 to 24.

Journées Médicales Marseillaises et Coloniales (at Marseilles).—Prof. Cantacuzène: The Rôle of the Streptococcus in the Etiology of Scarlet Fever.—Dr. Mayer. Recent Advances in the Treatment of Cancer.—Prof. Ottolenghi: Malaria.—Dr. N. Bernard: Beri-beri.—Prof. Imbert: Bone-grafting.

April 25 to 28.

German Society for Internal Medicine (at Wiesbaden).—Discussions on Psychotherapy, introduced by Gaupp and Fleischmann; Results of Recent Functional Investigations of the Stomach and Duodenum, introduced by G. Katsch.—A joint meeting with the German Röntgen Society will be held on April 28, with a discussion on the Significance of Röntgen-ray Examination of the Lungs and Mediastinum for Internal Medicine (excluding Tuberculosis), introduced by Dietlen, Assmann, Haenisch and Lorey, and Fleischner.

SATURDAY, APRIL 16, 1927.

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The Development of Natural History Museums.

AT the present time there are scores of natural history museums, national, municipal, and semi-private, scattered throughout the British Isles, all attempting to serve science by presenting to the people the crude material of scientific study and, less generally, the results of certain kinds of scientific research. Their condition causes uneasiness to the onlooker who realises how potent an instrument museums might be in instilling scientific knowledge and creating that staunch popular backing which is necessary to bring science to its own in the life of the nation.

The story of many, perhaps the majority, of provincial museums is the same. They begin in a burst of enthusiasm, the white heat wanes, the care of the collection falls upon a dwindling number of voluntary workers, there is no proper provision for upkeep, and the end is disrepair, mouldy collections, dust-laden shelves—the 'museum' of the comic papers. These museums need encouragement, help, and money. The Carnegie United Kingdom Trustees have decided upon a work of national importance in undertaking, with the help of Sir Henry Miers, an inquiry into the conditions of these "imperfectly organised and to a large extent unappreciated" institutions. The national museums and the museums of the larger municipalities stand in a different category. They are for the most part well tended and well cared for, their exhibited collections are kept up-to-date, in so far as up-to-dateness is satisfied by the replacement of poor specimens, the occasional filling in of blanks and a little more. But have even these museums realised the need of marching with the advance in knowledge?

The purpose of a great natural history museum is twofold, as Sir Ray Lankester has pointed out in a recent letter to NATURE (Feb. 26, p. 314). It is a storehouse for the safeguarding of objects of natural history which are of historic interest, and of the vast collections of specimens gathered from every quarter of the globe and from the world's seas. On these are founded to a large extent our knowledge of the basic natural history of geographical regions, and they afford the raw material for further researches, geographical, morphological, and phylogenetic. Much more importantly, so far as the living generation is concerned, they give the ordered facts on which alone can be based the war against disease, and the search for Nature's wealth, which together determine the economic fate of the human race; but this is an aspect which demands description by specialists. For all these ends the storing of such material, if it is to be at all valuable for reference, demands a minuteness of classification in proportion to the extent of the collections, and therefore a prime duty of a museum staff must be that of the systematic classifier.

The other great purpose of the large museum (and almost the sole purpose of the small museum) is exhibitory and educative, for the instruction not only of the unlearned but inquiring public, but also of all grades of receptive mind even to the professional expert, since there is no book-knowledge but may be bettered by reference to the facts themselves, and these could often be displayed from the great stores of museum properties. The growing recognition that an essential duty of museums supported by the public purse is educative, is shown in the placing of the newer State museums under the departments identified with public education, the Victoria and Albert Museum under the Board of Education, the Royal Scottish Museum under the Scottish Education Department. It is a kind of linkage that might well be extended to other public museums, provided the State department concerned is prepared to recognise and develop the enormous teaching potentiality of museums instead of permitting them to adhere as excrescences on the educational body.

Have the natural history museums in Britain played up to their educational function? They have not. Take the Natural History Museum at South Kensington, not because it is worse than the others, but because its size emphasises the defects. Its galleries are for the great part filled with thousands of specimens arranged 'systematically.' The principle underlying systematic natural history is phylogeny, that is to say, systematic collections must be looked upon as illustrating natural relationships and ultimately the evolution of life upon the globe. Since no one can claim that these great collections with their multiplicity of genera and species *visibly demonstrate* throughout the series natural relationships or the lineage of animal life, their primary purpose fails, and they must be regarded mainly as groupings convenient for showing a conspectus of the animal world and for the identification of specimens.

How do the collections meet these needs? It is impossible as a matter of quantity to exhibit every species; it would be useless from a qualitative point of view to do so, for the discrimination of the modern expert seizes upon differences invisible even to the observant eye. But this impossibility makes accurate identification from the exhibited collections a hazardous matter for the non-expert. The collections meet neither the phylogenetic nor the identification point of view. The indication is that their future development must be along the lines of drastic reduction, so that the series shall contain only readily distinguishable forms selected because of their historical, phylogenetic, or morphological interest, or because of a special attractiveness in themselves.

The implication of such a reduction is important. It means that, more and more, not only the specialist but also the general inquirer after detailed knowledge must be encouraged to supplement his observations in the galleries by appeal to the cabinet collections. This demands the presence of facilities not at present available in the museum, of easily accessible store collections, of well-lit, well-equipped, reasonably comfortable rooms available for the outside inquirer. Much more it implies such facilities for the museum staff which spends a lifetime organising and sorting the collections in gallery and in cabinet. Hitherto, in this technical aspect of reference collections containing specimens authoritatively named, the British Museum has been the central museum of the world. This position depends largely on the proportion of original specimens, 'type-specimens,' deposited by the naturalists who have named them; and obviously, the museum which has already the widest collection is the museum in which a new type-specimen can be most usefully deposited. It is to examine these type-specimens that naturalists visit England from all over the world. The hidden cabinets form the 'British Museum' which is the premier natural history museum in the world; it remains to be seen whether it can retain this position in face of the intelligent expenditure of America and Germany.

Sir Ray Lankester suggests that the exhibition space saved (and he contemplates reduction by one-half) might be used for the purpose of bringing up-to-date this hidden British Museum of research. With this view we disagree. There is a better purpose for the exhibition space, for the Natural History Museum has scarcely touched the fringe of real education, which must become part of the duty of a State museum. The greater American museums have spent much ingenuity and vast sums of money on the creation of realistic Nature groups, which transport the spectator into new realms. The main hall of the Natural History Museum at South Kensington, with its dark alcoves, is admirably adapted for such groups, and might well be given over to this purpose. But while such groups are instructive, their main interest is spectacular, and the public demands more than a pageant: it thirsts for a deeper knowledge.

Nearly seventy years ago, Charles Darwin, an Englishman, with a new view-point revolutionised the thought of the world. What has the Natural History Museum of his own country done to make Darwin's world-moving discoveries current amongst his own people? What has it done to convert the 'fundamentalists,' of whom Great Britain as well as America has its share? Nothing! Except for a few isolated exhibits, shown almost in holes and corners as if with an apology lest they should intrude upon the systematic collections. Yet Darwin's mind was detailed and material; his theories are not as it were in the air; they rest upon accumulated facts and examples of a kind eminently suitable for exhibition in a museum. Some years ago the late Dr. Benjamin Peach in arranging the collections of Hugh Miller in the Royal Scottish Museum, Edinburgh, placed together a few of the actual specimens which had led the Cromarty stone-mason to certain of his conclusions. This practice might be extended. There is a vast body of general biological truths of vital importance in scientific thought, which could be illustrated, not by one or two examples, but by such a multiplicity of examples, culled from a wide range in the realms of zoology and botany, as would compel belief. Sir Ray Lankester thinks that such subjects—evolution, heredity, variation, natural selection, geographical distribution and variation, sex dimorphism, and hosts of others—should be the subject of museum lectures, and with this view we are in entire agreement; but how much more ought they to fill the galleries of a public museum for the constant reference and edification of the people?

Such collections to reach their highest efficiency must be planned and wrought out with a breadth of knowledge, and with a museum gift which is comparable to the creation of a striking and artistic poster; to them each specialist must make his contribution; they must be symposia rather than individual efforts. The hard-pressed specialists on the museum staff, overladen with identification and classification and the sorting of new collections, cannot spare the time and consideration demanded by such biological exhibits. The ideal exhibitor is by nature a creative artist; the British Museum authority, to consult whom a zoologist comes from Japan or a tropical pathologist from Uganda, should be by training a field-naturalist, must be by nature a methodist and a scholiast. The reorganisation of the exhibited collections on the lines of the advancement of modern natural history demands the reorganisation of the staff.

On this, as well as on the grounds summarised by Sir Ray Lankester, an inquiry by Royal Commission into the "status, purposes, and organisation of the British Museum (Natural History) and other related institutions" is urgently needed. There are many aspects of museum activities, relationships, and influences which might be bettered by inquiry and definition: the aims of the museum itself; the overlapping and duplication of collections in London; the relation of the State museum as an educator, to the recognised educational and particularly the teaching institutes; its relation to other natural history museums supported by State funds, and to the public museums of Great Britain in general; and not least, when the Dominions, Crown Colonies and dependencies are equipping staffs of researchers into the Nature which surrounds them and the death which encompasses them, who risk their lives to fight disease and to bear the torch of scientific knowledge to the ends of the earth, let the Government of our Empire consider the imperial relationships of the British Museum.

Ethnology of Tuareg Tribes.

People of the Veil: being an Account of the Habits, Organisation and History of the Wandering Tuareg Tribes which inhabit the Mountains of Air or Asben in the Central Sahara. By Francis Rennell Rodd. Pp. xvi + 504 + 51 plates. (London: Macmillan and Co., Ltd., 1926.) 30*s*. net.

By the "People of the Veil" are meant the Tuareg, whose country extends from the eastern edge of the central Sahara to the far edge of the western deserts of North Africa before the Atlantic zone begins, and from southern Algeria in the north to the Niger and the equatorial belt between the river and Lake Chad in the south. The name 'Tuareg' is not used by the people themselves; it is really a term of opprobrium originally applied to them by their enemies. They became known to the Arabs as the 'Veiled People,' because their men after reaching a certain age were, as they still are, in the habit of wearing a strip of thin cloth wound around their heads in such a manner as to form a hood over the eyes and a covering over the mouth and nostrils. only a narrow slit being left open for the eyes; and, in default of a national name, they themselves use the same locution in their own tongue to describe the whole society of different castes which compose their community. They are usually included among the Berbers of North Africa; but Mr. Francis Rennell Rodd, the author of the latest book dealing with them, prefers to use the geographical term Libyans, and even doubts whether the Tuareg are Berbers at all, like the other people so called in Algeria and Morocco. There are to-day four principal divisions of them. One of these groups consists of the people inhabiting Air, which is a mountainous oasis situated on a great caravan road from the Mediterranean to central Africa; and it is chiefly with this people and their country that Mr. Rodd's book deals in detail, as a result of a nine months' journey in the Tuareg country.

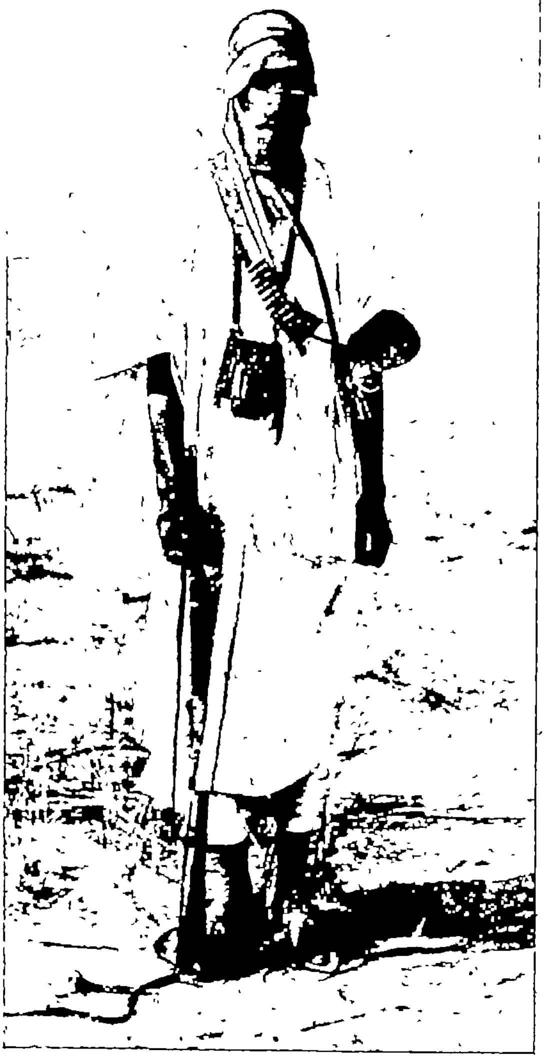
Fig. 1.—Tuareg camel-driver. From "People of the Veil."

The people of Air have for several centuries had a king, residing in the city of Agades, but he seems never to have enjoyed much authority, unless backed by the more important chiefs. His office is not hereditary, but he is elected by the representatives of certain tribes; and his tenure of office has always been very precarious. The reigning king is of slave descent, and the same has been the case with all his predecessors. The legal practice of slavery has of course been abolished in Air since the advent of the French in the beginning of the present century, but master and slave continue to regard each other by mutual consent in the light of their former relationship. Slavery among the Tuareg never involved great hardship; it was in slave-trading and not in slave-owning that they sinned against the ethical standards which are usually accepted in Europe. There are further the so-called *imghad*, or serfs, who are clearly the descendants of groups or individuals captured in war and afterwards released from bondage to form a caste enjoying a certain amount of freedom; they are in no sense considered to be the property of the noble tribe which originally possessed them, but the relationship is closer than that of suzerain and vassal. In the first stage the noble tribe represents the original pure Tuareg race, while the oldest *imghad* are the first extraneous people whom they conquered, "in some cases perhaps as early as in the Neolithic ages."

In addition to the social distinction between nobles and serfs, the Tuareg attach great importance to tribal classification. Among the inhabitants of the Air mountains a tribe is either of the category called the "People of the King" or of the Kel Owi, and this distinction means all that the difference between an ancient landed nobility and a parvenu commercial aristocracy denotes. Many of the older men of the "People of the King" say that there are no nobles among the Kel Owi at all.

In Air, as elsewhere among the Tuareg, a man's or woman's social status is determined by that of the mother; a woman, they say, carries her children before they are born, and so they belong to her and not to the father. If she marries a man of another tribe the children become members not of his but of her tribe; and Mr. Rodd states that "should inter-tribal hostilities break out they must leave their father and fight for their mother's tribe, even against their own parent if need so be." Similar statements have been made with reference to a few matrilineal peoples in other parts of the world, but they are quite exceptional and even of doubtful accuracy; hence it would have been well if the author had confirmed his assertion by actual cases in which Tuareg have been at war with their fathers on account of their method of tracing descent through the mother. He maintains that the frequency of monogamy is connected with the 'matriarchate.' But his statement relating to the Tuareg of Air, that in practice "monogamy is more frequent than polygamy," is true of all Muhammadan nations and of nearly all other peoples who allow polygamy, and nobody has ever been able to show that patrilineal peoples are more addicted to it than matrilineal ones; indeed, the prevalence of mother-right has, on the contrary, been partly traced to the practice of polygamy. Monogamy may certainly be a result of the regard in which women are held; but the supposition that their position in general is influenced by the system of reckoning kinship is not past all doubt.

Mr. Rodd observes that the Tuareg women are respected by their men in a manner which has no parallel in his experience, and that their unveiled countenances are in keeping with the perfect freedom they enjoy—though, wisely enough, he does not attribute the veil worn by the men to female supremacy. There can be little doubt that the veiling of women found in many parts of the Muhammadan world is not merely due to masculine jealousy but serves the object of protecting them from the evil eye, and in early Arabia very handsome men for the same reason veiled their faces, particularly at feasts and fairs; but though the belief in the evil eye is known to exist among the Tuareg, it does not seem to have anything to do with the veiling of their men. The author criticises some theories as to the origin of this peculiar custom, and is of opinion that up to the present no reasonable theory has been advanced. I think, however, that he has made a little too light of the suggestion that the veil was assumed by raiders who wanted to conceal their faces in order to escape recognition; he argues that the veil would be of little use as a means of concealment. I have heard Moors who have come in contact with Tuareg express a very different opinion, and among the mountaineers of northern Morocco robbers blacken their faces so as not to be found out. The veil is not worn until some years have elapsed after the youth begins to carry a sword.

While Mr. Rodd gives us much minute and valuable information about the organisation, the social conditions, the mode of life, the trade and occupations, the architecture and art, and the history of the Tuareg of Air, he has much less to tell of their rites and beliefs. Only a few lines are devoted to their customs connected with childbirth, marriage, and death, which may not be so uninteresting as he assumes; and he modestly says that he was not sufficiently fluent in their language to learn much of their superstitions. "Such information," he rightly remarks, "can only be obtained after prolonged residence among a people." He believes that the frequent use of the cross in Tuareg ornamentation is due to early Christian influence. It may be so; but the cross is much older than Christianity, and cruciform devices occur among the tattoo-marks seen on Libyans represented on old Egyptian monuments.

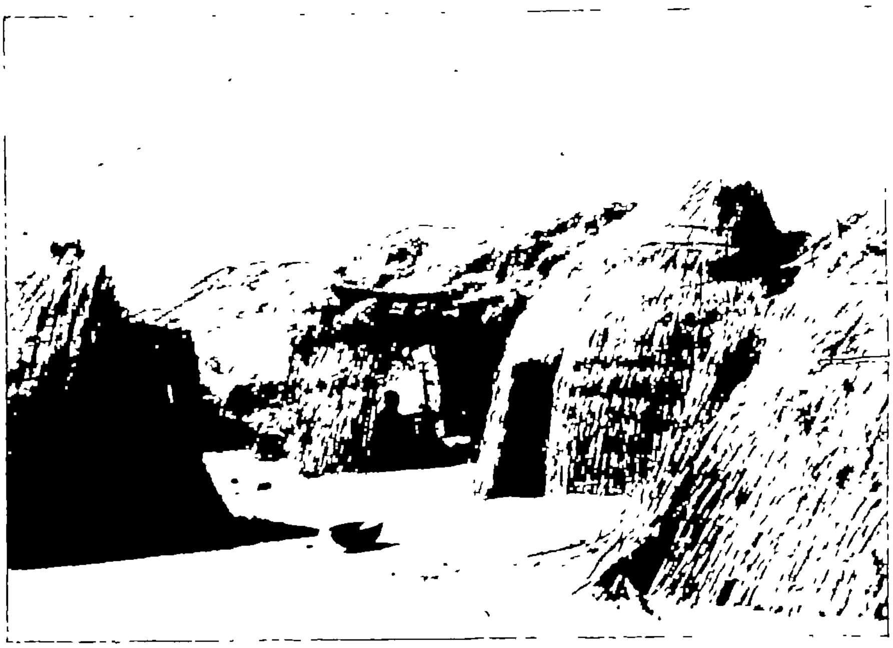

Fig. 1.—Tuareg huts at Auderas. From "People of the Veil."

It should be added that Mr. Rodd's book is an important contribution not only to our knowledge of the Tuareg, but also to the study of certain problems relating to the history and ethnology of the Sahara and North Africa in general. The illustrations are excellent. Edward Westermarck.

Q 1

Atomic Physics.

The Structure of the Atom. By Prof. E. N. da C. Andrade. Third edition, revised and enlarged. Pp. xviii + 750. (London: G. Bell and Sons, Ltd., 1927.) 30*s*. net.

PROF. ANDRADE'S well-known introduction to atomic physics has been very largely re-written for this (the third) edition, and the size of the work has been approximately doubled. Some of the discussions of the earlier editions have been amplified, but in the main the increase in size represents the introduction of new subject matter. As before, the book is divided into two parts, of which the first is nominally devoted to the nucleus. A great deal of extranuclear matter is, however, disposed of in this section, in order to clear the ground for the later discussion of the outlying portions of the atom.

After a brief historical introduction, pride of place is appropriately given to an admirable account of the passage of swift electrified particles through matter—the problem which primarily led to the enthronement of the nuclear theory of the atom. Rutherford's α-particle scattering is naturally dealt with in some detail, together with an outline of the rather less definite evidence obtained from β-particle scattering. There is also a (much too brief) reference to the fundamentally important observations of Ramsauer and others on the behaviour of inert gases towards slow cathode rays—observations now extended, with refined methods, to the more 'aggressive' gases.

Part I. is also distinguished by an excellent account of the remarkable work conducted by Rutherford and his school during the last eight years, on the effects of extremely close collisions between swift α-particles and the nuclei of light atoms—the 'artificial' disintegration of matter and the estimation of the 'size' of the nucleus. Other topics which are concisely but adequately presented are: positive rays (including Aston's work on isotopes), the evidence for 'energy levels' within the nucleus, the interpretation of β- and γ-ray spectra and the deduction therefrom of details of the process of radioactive disintegration. Separate chapters are devoted respectively to more speculative hypotheses on the structure of the nucleus, and to an excellent account of 'classical' X-ray work—including Moseley's establishment of the importance of the concept of atomic number, Barkla's application of the scattering formula to the determination of the number of extranuclear electrons, and W. L. Bragg's work on the average time-spatial distribution of these electrons. The necessary 'Digression' on optical spectra, which has been modified and enlarged, brings Part I. to a close.

Part II., which now occupies about three-fourths of the whole book, deals exclusively with the behaviour of the extranuclear electrons, and almost exclusively with the quantum explanations of this behaviour. A great deal of space is therefore allotted to the discussion of spectral series. This part of the discussion, which has been profoundly modified in the new edition, begins, inevitably, with the classical Bohr theory of the spectra of hydrogen and of ionised helium. This is followed by simplified expositions of Ehrenfest's adiabatic principle and Bohr's correspondence principle. The argument is then carried on to the case of 'hydrogen-like' atoms, in which two quantum conditions are required for the specification of the orbits, and to the problems of 'relativistic' fine structure, normal Zeeman- and first-order Stark effects. Examples are given of Sommerfeld's classical applications of the 'Sommerfeld–Wilson' quantising rules and of Bohr's use of the method of perturbations. After a preliminary attack on the spectrum of the general atom, with the evocation of selection rules and adoption of a third and fourth quantum number, the discussion of the spectroscopic evidence culminates in a remarkable chapter on multiplet theory and anomalous Zeeman effect. This chapter (xv.), which has been partially revised by Mr. R. H. Fowler, summarises some of the most eminent successes, and at the same time emphasises some of the most significant difficulties and inadequacies of the older quantum theory of line spectra.

Among other new chapters which enhance the value of the book, special reference must be made to an excellent summary of work on critical potentials. There is a particularly welcome account of Saha's theory—which is not always, even in astrophysical text-books, given the place it merits—and the extensions of Fowler and Milne. Klein and Rosseland's superelastic collisions, and resonance radiation (including quenching and 'sensitised fluorescence'), are briefly discussed.

The account of the evidence from X-ray spectra has been very considerably expanded, and now occupies a separate chapter. This chapter gives a useful account of measurements in 'soft' X-ray regions and of the transition from optical to X-ray spectra, and a brief discussion of the interesting dilemma of the 'relativity' doublets raised by the recent 'hot spark' work of Millikan and others.

The relation of the dynamical atom-model to the periodic system of the elements is much more fully discussed than in the earlier editions. An account is given of the Stoner–Main Smith modification of Bohr's original scheme, and McLennan's new table of basic spectral terms is added in an appendix (v.).

The chief addition to the chapter on magnetism is the extended account of the beautiful experiments of Gerlach and Stern, which is supplemented by a particularly fine reproduction of some of the original photographs. There is, however, no discussion of Glaser's work on diamagnetic gases at low pressures.

The relative positions of wave theory and classical quantum theory are summarised in a new chapter, which deals with dispersion, the Bohr–Kramers–Slater discussion of radiation fields, and the Compton effect.

The book closes with a brief but suggestive statement of the present position, and an account of the salient features of the newer quantum theory —or what seems doomed to be known for the present as the 'Born–Jordan–Heisenberg–Pauli–Dirac–Schrödinger . . .' mechanics.

The above—necessarily imperfect—analysis of the subject matter is intended to indicate the scope of the work, which is in many respects complementary to that of Sommerfeld's well-known treatise. It should be obvious that the book is primarily addressed to the traditional 'serious student' of physics. The treatment is, however, so ordered that much of the text is accessible to readers who have a general rather than a professional interest in modern speculations on the structure of matter.

The general plan has been to give a lucid account of the essential features of each problem, and to supplement this by a judicious selection of references to original sources. Space is economised here and there by omitting details for which English readers would naturally turn to such standard treatises as those of the Braggs, Aston, or Siegbahn. The result of this plan has been the production of a book which is specially adapted to serve as a general guide for senior students of physics and for those who are preparing to embark upon independent work. There are also, unfortunately, many older experimenters whose employment leaves them little time to keep in touch with new work which does not bear obviously and directly upon the subjects of their own special studies: to these, too, Andrade's book will make a special appeal.

The appeal in many cases will be none the weaker because the treatment is throughout physical rather than mathematical; and although the greater part of the book is necessarily allocated to the theoretical superstructure, unusual attention and respect are paid to the experimental methods and observational data at the foundations. The information has not always been brought completely up-to-date—it is many months since X-ray spectroscopy stopped short at such puny wave-lengths as 14 Å.U., and it is no longer held to be established that the absorption edges of an element depend upon the allotropic form, though it has been shown that the effect of valency can be exhibited even in the X-ray emission spectra of compounds—but oversights of this nature are inevitable in so comprehensive a survey. Certain omissions—as that of any discussion of band spectra—were also inevitable, as is pointed out in the author's preface; perhaps one of the most regrettable is the absence of any detailed discussion of the outstanding problem of X-ray absorption. As the problem by its nature is rebellious to direct treatment by the correspondence principle, which is the key to so great a part of the book, this omission is not unnatural.

Even if, as the author forecasts, much of the book will need to be rewritten in terms of the new mechanics and the spinning electron, the work in its present form stands as a very valuable exposition of the existing state of our knowledge of atomic structure, and one which is not likely to be superseded in the near future. The advances made even as the book was passing through the press are sufficient to demonstrate the futility of any immediate attempt to assemble, in a work of this kind, more than the barest outlines of the new methods of attack. It is to be hoped, however, that in the next edition it will be possible to include an account of the newer physics which, as yet, is but dimly to be discerned, stirring lightly in the matrices of the new dynamics.

The book is well produced, and the new plates are worthy companions to the beautiful reproductions in the earlier editions. The price has been increased—one serious defect in a book which is in all other respects so well adapted to the needs of the experimental physicist—but no one appreciating the amount of new work incorporated in this edition, or familiar with the cost of production of scientific books, will maintain that the increase is unwarranted. There is an excellent index, of the type (combined author and subject) which ought to be made compulsory in all books on physics.

H. R.

Cell Division.

Das Problem der Zellteilung physiologisch betrachtet. Von Prof. Alexander Gurwitsch. (Monographien aus dem Gesamtgebiet der Physiologie der Pflanzen und der Tiere, Band 11.) Pp. vii+221. (Berlin: Julius Springer, 1926.) 16·50 gold marks.

In this monograph the professor of histology at the University of Moscow puts together the results of a series of researches, carried out in his laboratory, which are so novel in outlook and method of experimental approach that some time must elapse before biologists in general can be prepared to express an opinion upon them. In introductory chapters the problem of cell division is approached in a somewhat artificial semi-philosophical manner, leading up to the general conclusion that the process of cell division is very largely determined as the result of influences received at the surface of the cell.

As possible influences leading to cell division upon reception at the cell surface two are considered: (1) Haberlandt's necro-hormone, a generalised suggestion arising out of experiments which led Haberlandt to think that the meristem divisions giving rise to wound cork were initiated in part as the result of substance diffusing from the wounded cells; (2) the 'mitogenetic' radiations, upon which much work has been done in Gurwitsch's laboratory. The regular cell divisions in the apical meristem of the onion root suggest an influence, inducing cell division, centred within, and radiating from, the apical meristem itself.

Gurwistch then proceeds to test the influence of this 'mitogenetic' radiation, emanating from the root apex, in inducing cell division in the still meristematic region of another root, when the apex of the first root is pointed, at close range, toward the flank of the second root. Normally, in the region behind the apex, when a root is examined, the number of cells found in division on either side of a median line through a longitudinal section is approximately the same. But when, on one side of this median line, the cells have been exposed to this 'mitogenetic' influence of another root apex, many more cells are found in stages of division on this side of the root.

In the main, this general line of experimental evidence is the chief evidence brought forward in support of this very new idea of a mitogenetic radiation. Modifications of the experiment lead to the conclusions that the rays are reflected from a plane glass surface, penetrate quartz, and are probably ultra-violet rays of wave-length between 1900 Å.U. and 2000 Å.U.

A few experiments with root extracts are given as evidence that these rays are released as the result of the interaction of a substance, 'mitotin,' with an enzyme 'mitotase,' on analogy with the phosphorescence of 'luciferin' under enzyme action. The experimental basis given for this conclusion is not, however, very complete. These views of Gurwitsch are given general application to the phenomena of cell division in both animal and plant; it remains to be seen how they will stand the test of time.

Our Bookshelf.

From Tribe to Empire: Social Organisation among Primitives and in the Ancient East. By Prof. A. Moret and G. Davy. Translated by V. Gordon Childe. (The History of Civilisation Series.) Pp. xxx+371. (London: Kegan Paul and Co., Ltd.; New York: Alfred A. Knopf, 1926.) 16*s*. net.

In his foreword, Mr. Henri Berr emphasises the importance of the social factor in history, and points out that in the early volumes of this series, which deals with the evolution of humanity, it has been necessary repeatedly to refer to the problem to which it gives rise. This volume thus marks a critical point in the general scheme of the series. For here we 'come to grips' with the problem. The aim of the book is to introduce the social as such into historical explanation. We find, therefore, that it falls into two parts. In the first part, six chapters introduce the reader to what is known of primitive social development, the material being arranged in a progressive framework. After a statement of the problem, it starts with the totemic organisation in which the individual is lost in the totemic group, or, perhaps it might almost be put, the individual is a function of the totem. It then traces the gradual development of individualised power. This is in effect the centralisation of the magic of the totem, of the land and the community, in one individual, the king. In Part 2 the transition of the clan to the kingdom is considered. This is traced in the early civilisation of Egypt and Mesopotamia. Finally, the working out of the social factor is studied in the first empires of the Orient, and the reader is carried down to the Egypto-Hittite *entente* and the invasion of Egypt by the peoples of the sea in the Nineteenth Dynasty.

The application of primitive sociological data to the elucidation of archæological and historical problems is of course not new, but here it is conceived on a grand scale, and worked out in detail with much ingenuity. A word of caution may not be out of place. In this field much is uncertain, at any rate of early days. It is impossible, for example, to say how great was the extent of the subordination of the individual to the whole. The large generalisations based upon the application of the prevalent analysis to what is often the merest outline, give rise to an uneasy feeling that the interpretation of the more obscure facts has had to square with theory rather than that it has evolved naturally from the facts themselves. In other words, the argument from analogy may have been unduly strained in its application to the internal conditions of Egypt and Mesopotamia.

The Indian Zoological Memoirs on Indian Animal Types. 1: *Pheretima (The Common Indian Earthworm).* By Prof. Karm Narayan Bahl. Pp. iv + 72. (Lucknow: The Methodist Publishing House, 1926.) 1.8 rupees.

A COMMITTEE of zoologists in India has arranged for the preparation of a series of memoirs on the lines of the well-known memoirs published by the Liverpool Marine Biological Committee. Hitherto students of zoology in India, while dissecting Indian types of the various phyla, have had chiefly to use descriptions based on British representatives of those phyla. The present is the first of the series of memoirs on Indian animal types; others are contemplated on a leech, a starfish, a centipede, a scorpion, an ascidian, a dogfish, a catfish, and a lizard.

Prof. Bahl's account of the common Indian earthworm *Pheretima posthuma* sets a worthy standard for the series. The chapters deal successively with the habits and habitat, external features, body wall, cœlom, the alimentary canal, the vascular, excretory, nervous, and reproductive systems, and the development. A concluding chapter contains concise directions for practical work. As would be expected from the author's published papers, the accounts of the vascular and excretory systems are particularly full and well done; perhaps a little less detail in parts of the vascular system would have sufficed. In addition to the examination of the worm by dissection, due attention is devoted to the microscopic study of excised organs and tissues and of transverse sections. The volume is adequately illustrated by two half-tone plates and 29 line drawings in the text.

The author is to be congratulated upon his suggestion that memoirs on common Indian animals should be prepared, and upon his own excellent contribution to the series.

A Book of South African Flowers. By D. Barclay, H. M. L. Bolus and E. J. Steer. Pp. xviii + 174 (57 plates). (Capetown and Johannesburg: The Specialty Press of South Africa, Ltd.; London: L. Reeve and Co., Ltd., 1925) 21*s*.

SINCE its discovery, visitors have been struck by the remarkable flora of Cape Colony, and especially of the particular region known to botanists as the "South-western Region." Here the landscape is often dominated by such unique types of plants as Protea, Leucadendron, Strelitzia, etc., which are found nowhere else in the world. In order to spread a wider knowledge of these interesting and beautiful plants "among those for whom the purely scientific botanical books have little or no meaning," the Wild Flower Protection Society has published a book with illustrations, accompanied by interesting biological notes suitable for the ordinary reader. Most of the plants described are those which were in danger of becoming extinct from various causes, mainly, however, the Capetown flower-seller, and are now protected by law from being destroyed. Thirty-two of these are illustrated by coloured plates, some of them good, some rather poor, and the remainder by photographs. The text has been written by Mrs. Bolus, the Curator of the Bolus Herbarium, Kirstenbosch, the drawings are by Miss Barclay, and the photographs by Mr. Steer. We feel sure not only that the authors' modest hope "that the book may prove useful in schools" will be fulfilled, but also that it will be just the thing for those interested in the Cape flora generally, and especially for the visitor with limited time who wishes to know something about the wild plants around him.

Practical Microscopy: an Introduction to Microscopical Methods. By Dr. F. Shillington Scales. Third edition. Pp. ix + 332. (London: Baillière, Tindall, and Cox, 1926.) 8*s*. 6*d*. net.

IN this third edition the author (whom death has recently claimed) has revised the text and introduced much new matter, particularly in the chapters dealing with the design of the microscope, choice of an instrument, objectives and accessories, and many of the newest models and pieces of apparatus are illustrated. The chapter on the practical optics of the microscope is exceedingly good, and gives all the essentials of the subject in simple form. A chapter on photo-micrography is included. The section on microscopical technique gives an excellent summary of the essentials of the subject—fixing, hardening, section cutting, staining and mounting—and the budding microscopist will find that it will carry him a long way in his work. Tables, formulæ, and a useful bibliography are included in an appendix. R. T. H.

The Goodness of Gods. By Prof. Edward Westermarck. (The Forum Series.) Pp. vi + 58. (London: Watts and Co., 1926.) 1*s*. net.

DR. WESTERMARCK's contribution to the "Forum Series" consists of four chapters in which he follows up the development of the idea of god from its earliest beginnings among primitive peoples in the belief in supernatural beings, to its fully developed form in the higher religions, the religion of the ancient Egyptians, Zoroastrianism, the Vedic religion, Christianity, and Mohammedanism. In the final chapter, "The Betterment of the Gods," the author deals specifically with the ethical side of his theory. The treatment in so small a compass is necessarily concise, and the reader is referred for the data upon which Dr. Westermarck's views are based to his "Origin and Development of the Moral Idea."

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

The Scattering of Electrons by a Single Crystal of Nickel.

In a series of experiments now in progress, we are directing a narrow beam of electrons normally against a target cut from a single crystal of nickel, and are measuring the intensity of scattering (number of electrons per unit solid angle with speeds near that of the bombarding electrons) in various directions in front of the target. The experimental arrangement is such that the intensity of scattering can be measured in any latitude from the equator (plane of the target) to within 20° of the pole (incident beam) and in any azimuth.

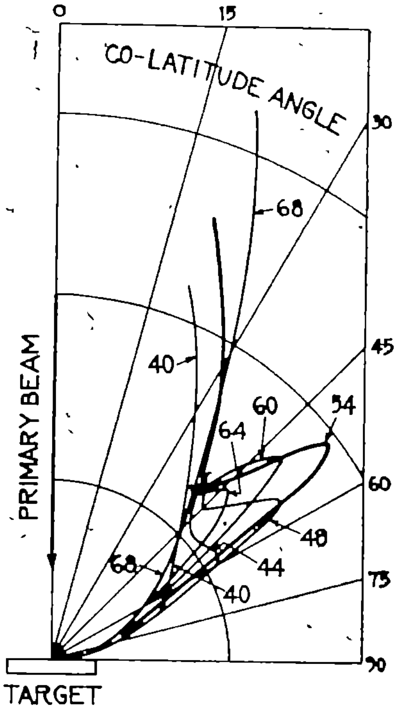

Fig. 1.—Intensity of electron scattering vs. co-latitude angle for various bombarding voltages—azimuth-{111}-330°

The face of the target is cut parallel to a set of {111}-planes of the crystal lattice, and etching by vaporisation has been employed to develop its surface into {111}-facets. The bombardment covers an area of about 2 mm.^{2} and is normal to these facets.

As viewed along the incident beam the arrangement of atoms in the crystal exhibits a threefold symmetry. Three {100}-normals equally spaced in azimuth emerge from the crystal in latitude 35°, and, midway in azimuth between these, three {111}-normals emerge in latitude 20°. It will be convenient to refer to the azimuth of any one of the {100}-normals as a {100}-azimuth, and to that of any one of the {111}-normals as a {111}-azimuth. A third set of azimuths must also be specified; this bisects the dihedral angle between adjacent {100}- and {111}-azimuths and includes a {110}-normal lying in the plane of the target. There are six such azimuths, and any one of these will be referred to as a {110}-azimuth. It follows from considerations of symmetry that if the intensity of scattering exhibits a dependence upon azimuth as we pass from a {100}-azimuth to the next adjacent {111}-azimuth (60°), the same dependence must be exhibited in the reverse order as we continue on through 60° to the next following {100}-azimuth. Dependence on azimuth must be an even function of period $2\pi/3$.

In general, if bombarding potential and azimuth are fixed and exploration is made in latitude, nothing very striking is observed. The intensity of scattering increases continuously and regularly from zero in the plane of the target to a highest value in co-latitude 20°, the limit of observations. If bombarding potential and co-latitude are fixed and exploration is made in azimuth, a variation in the intensity of scattering of the type to be expected is always observed, but in general this variation is slight, amounting in some cases to not more than a few per cent. of the average intensity. This is the nature of the scattering for bombarding potentials in the range from 15 volts to near 40 volts.

At 40 volts a slight hump appears near 60° in the co-latitude curve for azimuth-{111}. This hump develops rapidly with increasing voltage into a strong spur, at the same time moving slowly upward toward the incident beam. It attains a maximum intensity in co-latitude 50° for a bombarding potential of 54 volts, then decreases in intensity, and disappears in co-latitude 45° at about 66 volts. The growth and decay of this spur are traced in Fig. 1.

A section in azimuth through this spur at its maximum (Fig. 2—Azimuth-330°) shows that it is sharp in azimuth as well as in latitude, and that it forms one of a set of three such spurs, as was to be expected. The width of these spurs both in latitude and in azimuth is almost completely accounted for by the low resolving power of the measuring device. *The spurs are due to beams of scattered electrons which are nearly if not quite as well defined as the primary beam.* The minor peaks occurring in the {100}-azimuth are sections of a similar set of spurs that attains its maximum development in co-latitude 44° for a bombarding potential of 65 volts.

Thirteen sets of beams similar to the one just described have been discovered in an exploration in the principal azimuths covering a voltage range from 15 volts to 200 volts. The data for these are set down on the left in Table I. (columns 1-4). Small corrections have been applied to the observed co-latitude angles to allow for the variation with angle of the 'background scattering,' and for a small angular displacement of the normal to the facets from the incident beam.

If the incident electron beam were replaced by a beam of monochromatic X-rays of adjustable wave-length, very similar phenomena would, of course, be observed. At particular values of wave-length, sets of three or of six diffraction beams would emerge from the incident side of the target. On the right in Table I. (columns 5, 6 and 7) are set down data for the ten sets of X-ray beams of longest wave-length which would occur within the angular range of our observations. Each of these first ten occurs in one of our three principal azimuths.

Several points of correlation will be noted between the two sets of data. Two points of difference will also be noted; the co-latitude angles of the electron beams are not those of the X-ray beams, and the three electron beams listed at the end of the Table appear to have no X-ray analogues.

The first of these differences is systematic and may be summarised quantitatively in a simple manner. If the crystal were contracted in the direction of the incident beam by a factor 0·7, the X-ray beams would be shifted to the smaller co-latitude angles θ′ (column 8), and would then agree in position fairly well with the observed electron beams—the average difference being 1·7°. Associated in this way there is a set of electron beams for each of the first ten sets of X-ray beams occurring in the range of observations, the electron beams for 110 volts alone being unaccounted for.

These results are highly suggestive, of course, of the ideas underlying the theory of wave mechanics, and we naturally inquire if the wave-length of the X-ray beam which we thus associate with a beam of electrons is in fact the h/mv of L. de Broglie. The comparison may be made, as it happens, without assuming a particular correspondence between X-ray and electron beams, and without use of the contraction factor. Quite independently of this factor, the wave-lengths of all possible X-ray beams satisfy the optical grating formula $n\lambda = d \sin \theta$, where d is the distance between lines or rows of atoms in the surface of the crystal—these lines being normal to the azimuth plane of the beam considered. For azimuths {111} and {100}, $d = 2{\cdot}15 \times 10^{-8}$ cm. and for azimuth {110}, $d = 1{\cdot}24 \times 10^{-8}$ cm. We apply this formula to the electron beams without regard to the conditions which determine their distribution in co-latitude angle. The correlation obtained by this procedure, between wave-length and electron speed v is set down in the last three columns of Table I.

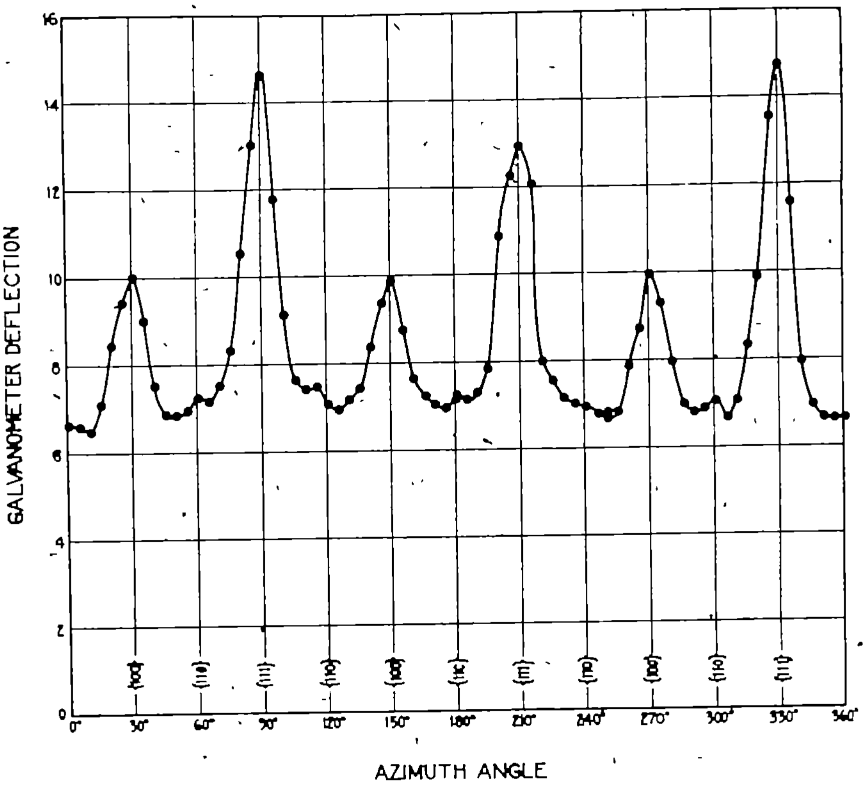

Fig. 2—Intensity of electron scattering vs. azimuth angle—54 volts, co-latitude 50°.

Table I.

Azimuth	Electron Beams.			X-ray Beams.						
	Bomb. Pot (volts)	Co-lat. θ.	Intensity.	Reflections.	λ × 10⁸ cm.	Co-lat θ.	Co-lat. θ′.	$v \times 10^{-8}$ cm./sec.	$n\lambda \times 10^8$ cm.	$n\left\{\frac{\lambda mv}{h}\right\}$.
{111}	54 100 174	50° 31 21	0·5 0·5 0·9	{220} {331} {442}	2·03 1·49 1·13	70·5 44·0 31·6	52·7 31·6 22·4	4·36 5·94 7·84	1·65 1·11 0·77	0·99 0·91 0·83
	174	55	0·15	{440}	1·01	70·5	52·7	7·84	1·76	2(0·95)
{100}	65 126 190	44 29 20	0·5 1·0 1·0	{311} {422} {533}	1·84 1·35 1·04	59·0 38·9 28·8	43·2 27·8 20·4	4·79 6·67 8·19	1·49 1·04 0·74	0·98 0·95 0·83
	159	61	0·4	{511}	1·05	77·9	59·0	7·49	1·88	2(0·97)
{110}	138 170	59 46	0·07 0·07	{420} {531}	1·22 1·04	78·5 57·1	59·5 41·7	6·98 7·75	1·06 0·89	1·02 0·95
{111} {100} {110}	110 110 110	58 58 58	0·15 0·15 0·25	. . . . . .	. . . . . .	. . . . . .	. . . . . .	6·23 6·23 6·23	1·82 1·82 1·05	1·56 1·56 0·90

In considering the computed values of $n(\lambda mv/h)$, listed in the last column, we should perhaps disregard those for the 110-volt beams at the bottom of the Table, as we have had reason already to regard these beams as in some way anomalous. The values for the other beams do, indeed, show a strong bias toward small integers, quite in agreement with the type of phenomenon suggested by the theory of wave mechanics. These integers, one and two, occur just as predicted upon the basis of the correlation between electron beams and X-ray beams obtained by use of the contraction factor. The systematic character of the departures from integers may be significant. We believe, however, that this results from imperfect alignment of the incident beam, or from other structural deficiencies in the apparatus. The greatest departures are for beams lying near the limit of our co-latitude range. The data for these are the least trustworthy.

C. Davisson.
L. H. Germer.

Bell Telephone Laboratories, Inc.,
New York, N.Y.,
Mar. 3.

The Brain of Laplace.

The bicentenary of the death of Newton (March 20, 1727) is within a fortnight of the centenary of the death of Laplace (March 5, 1827), and no one acquainted with the work of both can think of one or other except in association. It may, therefore, not be an unfitting occasion to refer to an historical point with regard to the great Frenchman, when we are celebrating the great Englishman.

The physiologist and anatomist Magendie propounded the theory that the intelligence of a human being was in the inverse ratio of the amount of cerebro-spinal fluid contained in the brain case. Writing in 1827, the year of Laplace's death, his "Mémoire physiologique sur le cerveau,"[1] he inserted the following words:

> "Je me suis trouvé dans la douloureuse nécessité d'examiner le cerveau d'un homme de génie mort dans un âge avancé, mais jouissant encore de la plénitude de ses facultés intellectuelles; la somme totale du liquide céphalo-spinal ne s'élevait pas à deux onces, et les cavités du cerveau en contenaient à peine un gros" [$=\frac{1}{8}$ once].

I have been unable so far to find any further reference in the writings of Magendie "to the brain of this man of genius who died at an advanced age" and in the fullness of his intellectual powers. Magendie appears to have given no further account of this brain; at least I have found none. Laplace died at the age of seventy-eight in the year Magendie wrote. I have also failed to discover any minute record of Laplace's death which would suggest that an autopsy was made or was a "douloureuse nécessité." I would venture, therefore, to ask those who may be better acquainted than I am with the circumstances of Laplace's death to let me know why his brain came into Magendie's possession and whether a full report on it was ever written. Magendie, indeed, mentions no name, and this might lead one to consider his investigation of the matter was confidential. However, I think the ascription is certain, for quite recently Miss Helen Hunter Baillie—a lady who combines the blood of other famous anatomists with that of a famous author,[2] placed in the hands of Miss Miriam Tildesley a letter of Joanna Baillie to her great niece Miss Sophy Milligan. This letter, dated Hampstead, Monday, 1834, contains the following important paragraph:

> "My dear Sophy. . . . Dr. Somerville told us not long ago a whimsical circumstance regarding the head of La Place, the famous French astronomer. Some Ladies and Gentlemen went one day to the house of Majendie (sic!), the great anatomist, to see the brains of this Philosopher which they conjectured must be of a very ample size, and seeing a preparation on the table answering their expectation they were quite delighted. 'Ah! see what a superb brain, what organs, what developments! This accounts completely for all the astonishing power of his intellect, etc.' Majendie, who was behind them and overheard all this, stepped quietly forward and said: 'Yes, that is indeed a large brain, but it belonged to a poor Idiot, who when alive scarcely knew his right hand from his left. This, Ladies and Gentlemen' (handing to them a preparation of a remarkably small brain), 'this is the brain of La Place.' Dr. Somerville was told this anecdote by Majendie himself. . . .
>
> Your affectionate Aunt, J. Baillie."

This Dr. Somerville can scarcely be other than the physician, fellow of the Royal Society, and husband of Mary Somerville, the learned lady who studied Newton's "Principia" in the original, was the correspondent of Laplace, and paraphrased his "Mécanique Céleste." There can thus be no doubt that Magendie was in possession of the brain of Laplace, and very little doubt that the passage in the "Mémoire physiologique sur le cerveau," written 1827, refers to that brain. The questions I would put to the French readers of Nature are these: What became of Magendie's preparations? Have they, and with them Laplace's brain, survived until to-day? If so; has any one reported on it, or does any account by Magendie other than that I have cited, written or printed, exist? So few brains of great thinkers have been available for examination, that it would be a real disaster if Laplace's should have had only four lines devoted to it.

Karl Pearson.

Galton Laboratory,
University College, London,
Mar. 31.

The Microscopical Examination of Flint Surfaces.

During the course of my work in the experimental fracture of flint by (*a*) human blows delivered by a hammer-stone, (*b*) unguided percussion, (*c*) unguided pressure, and (*d*) the application of heat, it became, in my opinion, possible, by a close examination of an extensive series of each of the differing types of flaking produced by these various methods of fracture, to differentiate between the work of man, and that of Nature ("Pre-Palæolithic Man," W. E. Harrison, publisher, Ipswich). While engaged upon this research I was much interested to notice that not only the type of flaking of the different series served to distinguish them from each other, but also that this difference appeared to find support, though in a less obtrusive manner, *in the appearance of the surface of the flints* broken by the methods above enumerated.

Most of those who are familiar with fractured flints of prehistoric date will have probably noticed the marked differences, often observable to the naked eye, between, for example, specimens broken by thermal effects and others fractured by human blows. The surfaces of the flake-scars of the former exhibit, generally, a much duller, less bright, surface than those of the latter. It occurred to me that this difference was caused possibly by the fact that these surfaces differed in texture, and had thus offered a differing resistance to the natural force, or forces, responsible for the imposition of 'polish,' or 'gloss," upon the flake-scars of fractured flints. Further, it seemed highly probable that this difference in texture, if it existed, would have been most likely to have been produced by the two differing forms of fracture, and I compared, provisionally, the surfaces of a flint broken by thermal effects, to those of an apple which has been pulled in half with the hands and exhibits a rough surface, while I likened the surfaces of the flake-scars of the flint broken by human blows to the smooth surface of an apple cut in half by a knife.

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[1] Published by Magendie in his own *Journal de Physiologie expérimentale et pathologique*, Tome 8, p. 228, 1828.

[2] The mother of Joanna Baillie was sister of William and John Hunter.

In order to make some test of this theory, I procured examples of good, sound flint from the detritus-bed at the base of the Red Crag of Suffolk, and having fractured some by means of a hammer-stone, and others by putting them into a fire, thus producing flake-scars by (*a*) human blows and (*b*) thermal effects, I had photo-micrographs taken of the two surfaces in order to see if they differed in appearance. A number of specimens were examined and photographed, and the surfaces here illustrated (Figs. 1 and 2) may, I think, be said with fairness to be typical. Fig. 1 shows the type of surface produced by human blows, while Fig. 2 illustrates the type of surface produced by thermal fracturing. An examination of these illustrations will show that the two surfaces differ from each other, and that this difference takes the form of the greater or lesser number, and prominence, of the white markings visible on the photographs.

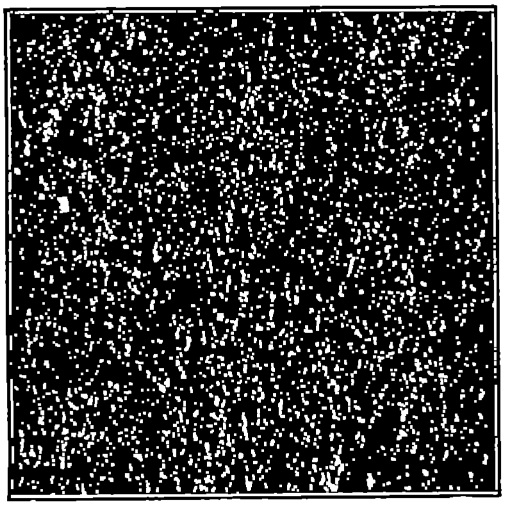

FIG. 1.—Photo-micrograph of surface of flint fractured by human blows. (×100)

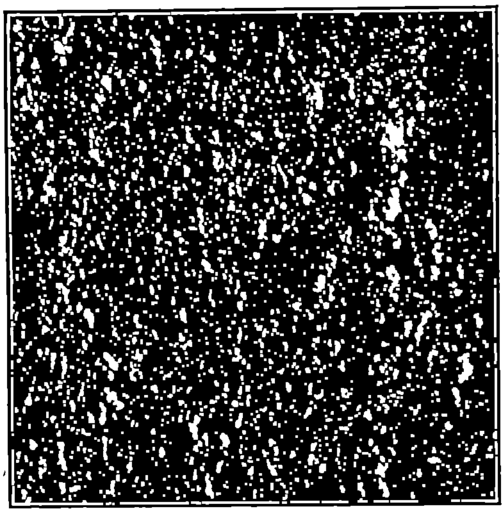

FIG. 2.—Photo-micrograph of surface of flint fractured by thermal agency. (×100.)

Though it is possible that these markings point to the 'thermal' surface being rougher than that produced by human blows, yet this is by no means certain. In fact, I am unable at present to say what these markings actually represent. But I believe that, though illustrating such a small area of the flint under examination, the photographs are representative of the two types of surface mentioned, and that the differences here indicated, plus the well-known other divergences between the flake-scars formed by human blows and thermal effects, now make it possible to differentiate, with confidence, between them.

I conceive that differences, though less easily observable, may exist between the surfaces of flints fractured by human blows and natural pressure, but so far I have not been able to establish this very important fact to my satisfaction. I believe, however, that this method of attempting to ascertain the manner in which a flint has been broken, though novel, has great possibilities before it, and will lead to very definite and valuable scientific results.

J. REID MOIR.

One House, Ipswich.

Haze.

WITH regard to the composition of the haze which often obstructs visibility in the summer, the following experiments may be of interest owing to the curious results and the make-shift methods which had to be used.

In August last, while staying on the coast of Norfolk, a well-marked haze appeared covering the whole country on Aug. 31 and Sept. 1. This had the characteristic bluish look often seen in summer haze. There was at the same time a strong wind blowing from the sea from north-west by north, which on Sept. 1 veered to nearly due north, the velocity being nearly 20 m.p.h. as measured by the flight of thistledown over a measured distance. The sea was rough, and the haze was such that the limit of visibility was about 5 miles.

Having no instruments with me with which to obtain samples of this haze, an instrument was improvised as shown on the sketch (Fig. 1). An empty peach tin 100 mm. diameter had a hole about 2 mm. diameter made in the centre of the bottom. The tin, A, was lashed to a piece of board with string, the bottom being brought up against a step, B, cut on the edge of the board; a microscope slide, C, was fixed opposite the hole in the bottom of the tin by means of a wedge, W, between it and the tin. This wedge also served the purpose of adjusting the distance between the slide and the hole to about 2 mm. The board carrying the tin was attached to a stake about 4 ft. 6 in. high, which was fixed in the ground with the mouth of the tin facing the wind.

A clean slide having been placed in position behind the tin, a definite patch became visible in 45 minutes on the glass opposite the hole, where the jet of air produced by the hole struck the slide. It was left in position for a little more than an hour, when the slide was removed and another put in its place which also received a patch visible to the naked eye. These patches, on examination under the microscope, were found to consist of a mixture of drops of liquid and crystals. The first consisted almost entirely of drops when examined, the relative humidity at the time being 82 per cent.

On warming gently all the drops dried, leaving crystals mostly of a skeletal form with branches at 90°, but some were cubical, while a few were thin rhomboidal plates, and these latter did not deliquesce as the others did when the slide cooled. The second slide was similar, except that there were in the drops larger numbers of rhomboidal crystals which showed no tendency to deliquesce, while on warming the slide numbers of cubical crystals appeared, with sides up to 24 μ, clearly of common salt; also a number of skeletal crystals with 90° arms (Fig. 2). It would appear, therefore, that this haze consisted almost entirely of crystalline salts, existing partly in the solid and partly in the deliquesced condition, and presumably mainly derived from sea spray, with crystals, probably sulphates, derived from the smoke of cities on the north-east coast. With such a dense supply of hygroscopic crystalline matter in the air it would seem certain that a liquid fog would result from the deliquescence of the crystals present long before saturation, indeed probably in the neighbourhood of 70 per cent. relative humidity. J. S. Owens.

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Westminster, S.W.1.

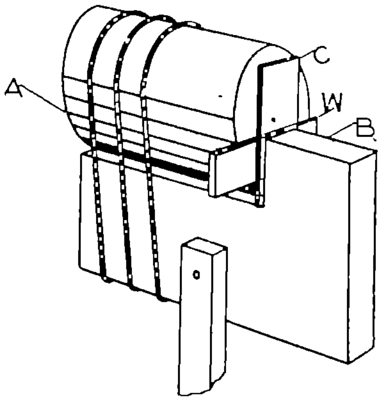

Fig. 1.

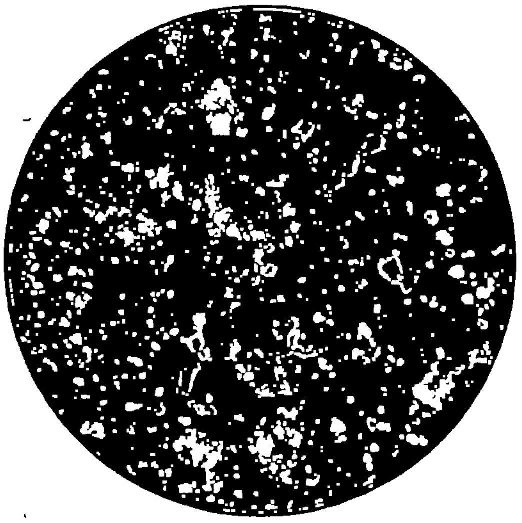

Fig. 2.

Hereditary Choice of Food Plants in the Lepidoptera and its Evolutionary Significance.

Mr. Edward Meyrick, in his comments (Nature, Mar. 12) upon my paper (*Proc. Roy. Soc.*, B, vol. 101, pp. 115-127) on the egg-laying instincts of *Pontania salicis*, so completely misses the point that it is difficult to deal with them seriously. The "new principle" to which he refers does not depend in the slightest upon the work he mentions, but is deduced from work described in an earlier paper (*Proc. Roy. Soc.*, B, vol. 99). It may be summed up in two sentences: (1) Chemical agencies acting through ingested food have been shown to act directly on the germ plasm so as to affect its potentialities; (2) Therefore any circumstance bringing about a change in the food ingested by an organism may affect its germ plasm so as to produce heritable variations.

Independently of this failure to appreciate the real foundation of the new principle, several other remarks of Mr. Meyrick require criticism. Amongst these is the statement that the only discrimination made by Salix-feeding Lepidoptera is in general between rough- and smooth-leaved species, and with this is coupled the remark that the influence determining the choice is touch rather than taste. Such views could not possibly emanate from one who has studied the matter in the field. I have recently been investigating the egg-laying habits of the moth *Ypsipetes ruberata*, which abounds here in a tangle of *Salix pentandra* and *S. aurita*. I can assure Mr. Meyrick that the females, when intent on egg-laying, never approach the *S. pentandra* to test the roughness of its foliage, but fly directly to the leaves of *S. aurita*. Moreover, I fail to see how their smoothness or the reverse can affect the choice of food-plant in the case of the lepidopterous *Xanthia flavago*, the coleopterous *Cryptorhynchus lapathi*, or the various Cecidomyids of the genus Rhabdophaga, which, with many other species, lepidopterous and otherwise, favour *S. aurita* in the same thicket but lay their eggs on the bark! The facts are, of course, that the two species of Salix support two very different faunas.

Further, Mr. Meyrick cannot really imagine that I think that the species employed as examples of allied pairs originated in Britain? I am quite well aware of their range outside our limits, but fail to grasp what this, or the exact locality in which they originated, has to do with the argument. Again, he seems to imply that I consider that a new species has been originated in three generations. No one ever claimed this; the experiments criticised dealt with only one point, that of egg-laying habits. Nevertheless, had Mr. Meyrick understood the principle, or the precise experiments upon which it was based, he would have realised, as is clearly stated in my paper but overlooked by him, that under its workings *Selenia bilunaria* diverged from the parent stock in wing colour and shape, length of larval life, and other features. These achievements may not, in Mr. Meyrick's eyes, go far to explain species-formation in the Lepidoptera, but still they do show how breaks from the original species arise which, in the end, may yield new species. One can expect little more in the lifetime of one worker!

Mr. Meyrick is correct in saying that entomologists have long noted that groups of related species feed on allied or associated plants and probably arose as phytophagous races. However, recognition of these facts is one thing, and an explanation on an experimental basis is another; this explanation I have endeavoured to supply.

As Mr. Meyrick speaks very definitely on the lack of variation, except in size, produced by food amongst the very variable, polyphagous British Caradrinidæ, he doubtless has access to experimental work bearing on the point. If so, these experiments are entirely unknown to me, and should be produced for the guidance of fellow-workers. The only pertinent researches on the Caradrinidæ with which I am acquainted are those of Hasebroek (*Zool. Jahrb., Abt. f. allg. Zool. u. Physiol.*, Bd. 37, 1919), and that investigator gives a very definite correlation between the food and certain phases of variation.

In conclusion, I plead for one thing, and that is the removal of the tendency to surround the results of researches in experimental evolution in a cloud of words; what is wanted is not words, but more experiments—and then still more!

J. W. HESLOP HARRISON.

Armstrong College,
Newcastle-upon-Tyne.

Biological Fact and Theory.

IT seems to me that all the facts of genetics must be accepted so far as they are supported by evidence, but the antagonism of some biologists is, I think, chiefly due to the complacency with which geneticists assume and assert that their discoveries explain all the important phenomena of biology, including the evolution of adaptations. Prof. T. H. Morgan believes that change of structure has been due to mutation, and that organisms have adapted their habits accordingly. I know of no case of mutation which is in any way parallel to the metamorphosis of the flat-fish or the frog.

The most crucial test, however, of the claims of genetics is the relation of sex-limited characters to the gonadial hormones. Prof. Morgan's view is that "supposing the testis hormone were the cause of strength and activity in the male which would be preserved and developed by natural selection, their secondary influence over other parts of the body would call for no other explanation." Obviously there is no suggestion here of any reason why the hormone should have a secondary influence over other parts of the body, or what determines the special result of the influence. The antlers of a stag have no essential relation to sex or reproduction at all, any more than its legs. Both legs and antlers are part of its hereditary constitution, but the latter depend for their normal development on the testis hormone, the former do not. Female secondary sexual characters, like the milk glands of mammals, are influenced by ovarian hormones. The only connexion with sex which such organs have is an external one, through function and habits. The antlers are only sexual in the use that is made of them in fighting between rival males. The testis hormone is much the same in all mammals; it is certain that there is nothing in the stag's hormone which would produce antlers in a horse or in a man. Why, then, should organs which have functions related to sexual habits be connected physiologically with the gonads or other reproductive organs?

There is nothing in all the facts of genetics or in the refinements of genetical theory, and nothing known about mutations, which throws light upon the relation of sex-limited characters to the sexual habits on one hand and to the gonads on the other.

J. T. CUNNINGHAM.

35 Wavendon Avenue, W.4,
Mar. 10.

THE discussion in NATURE under the above heading appears to me to be based in large measure upon failure to realise the character of scientific knowledge. Such misunderstanding is to be deprecated as being contrary to the interests of further progress in biology. I beg leave, therefore, to reiterate that scientific hypotheses, otherwise known as laws of Nature, are created by the mind of man for purposes of prediction and generalisation. They do not represent absolute truth, and are always liable to be superseded by new hypotheses which are more widely embracing. The Mendelian laws are no exception. So long as these laws fulfil the function of helping men of science to generalise and to predict they may be held to reflect definite degrees of reality. If, however, they fail to serve this purpose they have no logical justification.

Genes or factors, like atoms and molecules, are concepts invented by the human mind, but if their invention leads to increased complexity of thought rather than to simplification, it is both useless and unwarranted. I am not a geneticist, and to what extent, if any, such a perversion of sound scientific method is being made, it is not for me to say. Nevertheless, I suspect that much of the misunderstanding which has found expression concerning this subject would be resolved by a proper appreciation of the descriptive character of natural science and the limits of its domain.

F. H. A. MARSHALL.

Christ's College, Cambridge,
Mar. 27.

The Continuous Spectrum of β-Rays.

THE continuous spectrum of the β-rays arising from radio-active bodies is a matter of great importance in the study of their disintegration. Two opposite views have been held about the origin of this continuous spectrum. It has been suggested that, as in the α-ray case, the nucleus, at each disintegration, emits an electron having a fixed characteristic energy, and that this process is identical for different atoms of the same body. The continuous spectrum given by these disintegration electrons is then explained as being due to secondary effects, into the nature of which we need not enter here. The alternative theory supposes that the process of emission of the electron is not the same for different atoms, and that the continuous spectrum is a fundamental characteristic of the type of atom disintegrating. Discussion of these views has hitherto been concerned with the problem of whether or not certain specified secondary effects could produce the observed heterogenity, and although no satisfactory explanation has yet been given by the assumption of secondary effects, it was most important to clear up the problem by a direct method.

There is a ready means of distinguishing between the two views, since in one case a given quantity of energy would be emitted at each disintegration equal to or greater than the maximum energy observed in the electrons escaping from the atom, whereas in the second case the average energy per disintegration would be expected to equal the average energy of the particles emitted. If we were to measure the total energy given out by a known amount of material, as, for example, by enclosing it in a thick-walled calorimeter, then in the first case the heating effect should lead to an average energy per disintegration equal to or greater than the fastest electron emitted, no matter in what way this energy was afterwards split up by secondary effects. Since on the second hypothesis no secondary effects are presumed to be present, the heating effect should correspond simply to the average kinetic energy of the particles forming the continuous spectrum.

To avoid complications due to α-rays or to γ-rays from parent or successive atoms, we measured the heating effect in a thick-walled calorimeter of a known quantity of radium E. This measurement proved difficult because of the small rate of evolution of heat, but by taking special precautions it has been possible to show that the average energy emitted at each disintegration of radium E is 340,000±30,000 volts. This result is a striking confirmation of the hypothesis that the continuous spectrum is emitted as such from the nucleus, since the average energy of the particles as determined by ionisation measurements over the whole spectrum gives a value about 390,000 volts, whereas if the energy emitted per disintegration were equal to that of the fastest β-rays, the corresponding value of the heating would be three times as large—in fact, 1,050,000 volts.

Many interesting points are raised by the question of how a nucleus, otherwise quantised, can emit electrons with velocities varying over a wide range, but consideration of these will be deferred until the publication of the full results.

C. D. ELLIS.
W. A. WOOSTER.

Cavendish Laboratory,
Cambridge, Mar. 23.

The Coefficient of Ionisation of a Fused Salt.

IT is now forty years since Arrhenius and Van't Hoff put forward two independent methods for calculating the 'coefficient of ionisation' of a dissolved salt. The general concordance of their results provided a firm foundation for Arrhenius's theory of electrolytic dissociation, whilst the smaller discordances have provided material for the development of the later theory of complete ionisation. Since neither of the above methods could be used to determine the coefficient of ionisation of a fused salt, it has been supposed that the problem of determining this coefficient was insoluble. All the data that are required for a formal solution are, however, available for silver chloride at 600°, namely, molecular weight $M = 143{\cdot}34$, density $\delta = 5{\cdot}267 - 0{\cdot}00092\,t = 4{\cdot}715$, specific conductivity $\kappa = 4{\cdot}48$, viscosity $\eta = 0{\cdot}01606$ (at 603°).

The normality of the fused salt is $4715 \div 143{\cdot}34 = 32{\cdot}9\,N$; and the equivalent conductivity $\Lambda = 4{\cdot}48 \div 0{\cdot}0329 = 136$. A value for the equivalent conductivity, Λ_∞, of the completely ionised salt, can be deduced from the value in aqueous solutions, for which $\Lambda_\infty^{18} = 54 + 65 = 119$, by making a proportional correction for the increase of viscosity from 0·01056 to 0·01606; the value thus deduced is 78. Since, however, aqueous solutions are often abnormal, more importance attaches to a value deduced from Walden's relation, $\Lambda_\infty \eta_\infty \sqrt{M} = 11{\cdot}15$, which has been verified for six salts in 29 non-aqueous solvents, as well as for two 'anhydrous' salts in aqueous solution. For silver chloride, $\Lambda_\alpha = 11{\cdot}15 \div 0{\cdot}01606 \div 12 = 58$. The formal values for $\alpha = \Lambda/\Lambda_\infty$ are then $136 \div 78 = 1{\cdot}74$ and $136 \div 58 = 2{\cdot}35$.

Results such as these, indicating an ionisation of about 200 per cent., have perhaps been deduced before, but have been thought to be too absurd to justify publication. They represent, however, an anomaly which merits consideration. The view that *the ions of the solvent* exhibit an exceptionally great mobility may be true of water, but is certainly not true of other solvents, and cannot therefore be used as a general explanation of the high conductivity which is characteristic of many fused salts. It is therefore more plausible to attribute this effect to the presence of multiply-charged ionic aggregates, resembling the 'ionic micelle' of a colloidal electrolyte, since these would increase both the viscosity and the conductivity of the liquid.

T. M. LOWRY.

University Chemical Laboratory,
Cambridge.

Larger Aspects of Natural Selection.

THE brilliant researches of Harrison and Garrett, wherein they succeeded in producing heritable modifications in geometrid moths by the use of lead nitrate and manganese sulphate, suggest some reflections on the relation of these phenomena to natural selection. In 1908 I wrote (*Popular Science Monthly*, Dec. 1908, p. 547): "Speaking philosophically, progressive or orthogenetic evolution—the existence of which no naturalist has any ground for doubting—must have a cause external to itself. All probability favours the idea that this did not operate once for all, but has continued in action throughout the ages. It may be found, perhaps, in the susceptibility of the hereditary mechanism to environmental influences of particular kinds, the nature of which remains for the present obscure. These reactions would fall under the operation of natural selection from the very beginning; thus a too susceptible organism would quickly be thrown out of gear and would perish; a too conservative one, unless adapted to practically unchanging types of life, would equally perish. There would be a certain optimum susceptibility, which would be preserved, and would differ for different groups. More than this, certain kinds of susceptibility would be favoured, and being once developed might, like bad habits, become harmful through the accumulation of results, resulting in extinction."

Suppose that we think of mutations as chemical changes induced by certain agents, there is apparently no reason why any of them should be adaptive, or, as we say, 'purposeful.' Yet if we think of millions of such changes, occurring during millions of years, it is evident that natural selection must operate to sort out those substances the reactions of which are more or less likely to be beneficial. This process would not go beyond a certain point, because from the viewpoint of natural selection, it is the race and not the individual that matters. If once in a hundred or a thousand times a favourable reaction occurred, that might suffice; but if it never occurred, the line would probably eventually die out. There is thus some reason for expecting a higher percentage of favourable variations than would be expected on purely chemical grounds.

T. D. A. COCKERELL.

University of Colorado, Feb. 18.

The Control of the Beat of the Fan Segments in *Chætopterus variopedatus*.

WHILE studying regeneration in the tubiculous polychæt *Chætopterus variopedatus* (Renier), some observations were made of a different nature on the rhythmically beating fan segments.

In this worm there are three such segments which beat in a co-ordinated manner, producing a strong current through its tube. The most anterior seems to act as the pacemaker and half accomplishes its beat before the middle fan starts, and this in turn is similarly in advance of the posterior fan. This sequence persists even when the three segments are together isolated from the rest of the worm, but when isolated from each other they beat independently.

In each segment the ganglion is bilobed and the system of muscles, radial and circular, is bilaterally arranged. The intersegmental tissue is greatly constricted and the segments may readily be isolated with little injury, while the ganglion may be extirpated with a needle entirely or on one side only. When destroyed on both sides the contractions cease, but if on one side, the contractions of that side only are stopped, the other side continuing to beat in a relatively normal manner.

The anatomy of these structures has been described in detail by Joyeux-Laffuie (*Arch. Zool. exp. et gén.*, 8, p. 244; 1890). Thus each half of a fan segment acts as a single nerve muscle system under the control of the corresponding half of the ganglion, the action of which, however, is synchronised with that of the other, while the whole is subordinated, in the case of two out of three, to the influence of the segment immediately in front of it.

A further point of interest is that such isolated fan segments may readily be kept alive and beating in a stream of well-aerated sea water for four or five weeks, and so form promising material for further experimental work.

N. J. Berrill.

Zoological Department,
University College, London.

Numerical Solution of Algebraic Equations.

In his account of Newton's work in pure mathematics (Nature, Mar. 26, Suppt. p. 42), Prof. Mordell directs attention to the method of solving the cubic equation introduced by him. This method is in principle precisely that usually attributed to Horner; but the form quoted by Prof. Mordell is much more convenient in application than that given in most modern works on algebra. In the original form of the method, when we want to reduce the equation by 2, we replace y by $p+2$, and rearrange in powers of p. In the usual form we divide three times by $y-2$; thus in finding the coefficient of the second term we add 2 to the original coefficient three times instead of simply adding 6. The introduction of division resulted in a great increase in labour instead of a reduction. If there is any doubt, try it both ways and see!

The device of multiplying the roots by 10 is also, I think, undesirable, but less so. I have found it easier to dispense with it, noticing when the highest term has become too small to affect the answer. The whole equation should be multiplied by a power of 10 at intervals, so as to keep the coefficient of the *first* power of the unknown between 1 and 10.

Last year I had occasion to mark a number of solutions of a cubic equation produced in an examination. They included, to my surprise, a number by Tartaglia's method, which were almost as short as those obtained by the Newton-Horner method at its best. Tartaglia's method, of course, replaces the problem of solving the cubic by that of finding two cube roots, and in the absence of tables the extraction of one cube root is as difficult as the solution of the original equation. But tables of logarithms avoid this difficulty. For numerical work the disadvantages of Tartaglia's method, using tables, are first, that it does not work in the "irreducible case," and second, that it is not a particular case of a general method applicable to equations of all degrees.

Harold Jeffreys.

St. John's College, Cambridge.

Behind the Divining Rod.

I do not quite understand why Dr. Mill should assume (Nature, Mar. 26, p. 458) that the dowsers of my acquaintance are 'ignorant charlatans,' and they certainly have never 'impudently challenged' my studies, scientific or not. For my own part I regard these honest folk simply as self-deluded enthusiasts, and trust that no one will see in this a euphemistic equivalent; I am quite sure that at least one of my scientific friends would feel hurt if the term 'ignorant charlatan' were applied to his pet dowser.

It is fortunate that Dr. Mill knows an honest man of whose powers he is convinced. Here there is good material for serious investigation. Experiments might be devised to determine whether the subject responded to the influence of flowing water, but fortunately stationary metals, such as gold or silver, could be substituted for flowing water. This would simplify the procedure. I would suggest that a handful of similar coins, say French francs, which resemble gold, and English sovereigns, should be shuffled and then distributed into wooden boxes, all of the same size and outward appearance. The whole operation to be so conducted that the investigator himself should be ignorant of the location of the genuine noble metal and its simulacrum. This would exclude any telepathic influence. Should the dowser by 'spotting' the sovereigns emerge successfully from this test, there would then be good grounds for extended inquiry.

I may add that I am familiar with the one-sided presentation of the question which we owe to the advocacy of the late Sir William Barrett, and am unable to regard its evidence as convincing.

W. J. Sollas.

University Museum, Oxford,
Mar. 27.

Prof. Carl Runge.

Many of those who attended the meeting of Section A of the British Association at Oxford last August, distinguished as it was by the presence of so many spectroscopists and atomic theorists from various countries, will remember the peculiar pleasure, and one might say affection, roused by a really beautiful speech from that veteran mathematical spectroscopist, Prof. Runge; in which he expressed gratification at the brilliant results which were pouring forth on all sides as the outcome of earlier work in which he and some German colleagues had taken a leading part. In the peroration of that speech he pronounced on himself a touching *Nunc Dimittis*, which, alas, only five months later has been justified, though, as we learn from the obituary notice in Nature of April 9, p. 533, he had attained only seventy-one years of age.

Surely Runge felt the welcome which we gave him; and I will only quote, without comment, the concluding words of that obituary notice: "His son was killed early in the War."

Oliver Lodge.

April 9.

The Behaviour of Cultures of *Leishmania* sp. in *Phlebotomus papatasii*.

We must apologise for two errors in the note on the behaviour of cultures of Leishmania in *P. papatasii* (Nature, Jan. 8, p. 48). Sandfly No. 172 was not laboratory bred but was caught in Jerusalem, but as the infection rate in sandflies in Jerusalem is either nil or so small as to be negligible (not a single example of an infection was found during two years' dissection), this makes no difference to the conclusions deduced from the experiment. The inoculation was performed on Sept. 20, and not Sept. 26.

S. Adler.
O. Theodor.

Microbiological Institute,
Hebrew University,
Jerusalem, Feb. 14.

Philosophical Foundations of Quantum Theory.[1]

By Dr. P. Jordan, University of Göttingen.

The development of physics in the last decades has repeatedly raised epistemological questions of fundamental importance. Thus in the theory of relativity the problem of space and time received at least a temporary clarification. New questions have arisen in connexion with the quantum theory, and particularly the question of the existence of causal laws in elementary physical processes. Is the condition of an atomic system completely determined, or are there gaps in its determination?

Physicists no longer doubt that this question of the existence of a complete causal determination can only be settled by experience, and that causality is not an *a priori* necessity of thought. Certainly some degree of determinism is an essential condition for the possibility of physical science, as it is for any ordered and intelligible existence; and fortunately we have, if we confine ourselves to macroscopic phenomena, an apparently universal and trustworthy determinism. But for atomic phenomena this implies only a statistical determinism. The question of the causal necessity of the laws of an individual atom thus remains.

Before we attack this point it will be useful to give the notion of determinism a more precise consideration. The physicist cannot be satisfied with the approximate idea that we have of the meaning of this word. Nor is he interested in the metaphysical significance that some philosophers give it. For the physicist the definition of causality or determinism means the specification of conditions by which its existence may be experimentally established. This shows that the physical definition must continually change in accordance with the basis of our theories and facts and experimental methods. Let us consider first the rôle of causality in the classical physics of the field.

The contention of this classical physics is that the physical world may be described—and we use the word describe in a more or less purely geographical sense—by the specification of certain measurable quantities—fields, potentials, etc.—for every point of a four-dimensional region of space-time; and then the causal determinism consists in this. Let us consider a bounded volume of the space—say a parallelepiped. We shall not consider what modifications would be introduced into these considerations by taking complete account of the relativistic relations of space and time; but this would, of course, raise no difficulty. At a certain time—for example, at eleven o'clock—let the physical conditions inside the box be completely known and measured. Further, let the physical conditions of the entire surface of the box be specified from eleven until twelve o'clock. The physical phenomena in the whole box will then be uniquely determined from eleven to twelve o'clock. Thus, if we at any other time and place repeated the experiment, with the same initial conditions and the same course for the surface conditions, all of the phenomena inside the box would automatically be reproduced. Within a certain period of time—of the order of magnitude of the dimensions of the box divided by the velocity of light—the phenomena inside the box are independent of those on the surface.

These assertions are susceptible of experimental proof. Of course, we have to suppose at the beginning that the initial state within the box is not so complicated that its complete physical investigation would be entirely impossible. Thus we should have to exclude the case that there is a living organism in the box; for the notion that one could measure exactly the physical conditions is in this case not in accord with the experimental practicability. Thus the notion of determinism must be formulated differently for biology and for physics.

Let us therefore confine ourselves to a consideration of physical determinism. We may remark that this determinism is of an extraordinary kind; it is not at all equivalent to the mere existence of physical laws—the existence of mathematical relations between physical quantities. Moreover, we have here a peculiar asymmetry between the special and temporal co-ordinates; by this principle of determinism two temporally separate regions may influence each other physically; two spatially separated regions cannot.

The theoretical justification of this determinism arises from two circumstances. We shall mention these here without entering upon a mathematical proof that they really furnish this justification. In the first place, the physical laws—that is, the mathematical relations between the components of the field—are differential equations, and, in fact, to a first approximation, principally linear partial differential equations of the second order. In the second place, for the simplest four-dimensional geometry, in which the Pythagorean theorem remains valid, one must use, not the time itself, but the imaginary time, as fourth co-ordinate. If, instead of this, the four-dimensional manifold had four real dimensions, and the differential equation of physics remained unchanged, then we should have a much more complete determinism: one would then be able to deduce the state of any region of space-time from an accurate knowledge of any other specific region. If, on the other hand, the world had two real and two imaginary dimensions, there would be no determinism left. For in this case it would be possible for new motions suddenly to arise inside a box, even though there were no cause for them either within the box or at the boundary. This, then, is the significance of determinism for the physics of the field. It is not itself a natural law; the natural laws are the differential equations that lie at the basis of the physical field. It is a mathematical conclusion from these natural laws, a theorem from the mathematical theory of hyperbolic differential equations which has been applied to the laws of physics.

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[1] *Habilitationsvortrag* at the University of Gottingen. Translated by Mr. Robert Oppenheimer. The author is very much obliged to Mr. Oppenheimer for his careful translation.

It is on this account that one must be prepared to lose this determinism in the transition from classical physics to the quantum theory. For just those physical assumptions are here discarded which we have noted as theoretical support for the existence of determinism. Even the *description* of 'physical reality' cannot, as we now know, be given in terms taken from classical physics. Physical quantities are *not* continuously propagated through space; physical motions are not invariably continuous; there are elementary discontinuities, there are *quantum jumps*. What remains of determinism is not necessarily more than statistical. If we work with a great many similar atoms, or repeat very often experiments with a few, then we always get a result in agreement with the principle of determinism. We have seen before that physical determinism and physical laws were not co-extensive. We must, therefore, remark that in this case what we have said for determinism holds also for all physical laws. All we know at present are laws that are essentially statistical.

In recent times important advances have been made in the discovery of these laws. One can now, for example, compute (in principle) the spectrum connected with the motion of electrons in an atom with the same assurance as, on classical dynamics, one could calculate the motions of the planets. But in spite of the analogy between the calculations, there is an important difference in the interpretation of their results. The classical calculation gives us information about our specific system of planets. The quantum theoretical calculation does not, in general, tell us anything about a single atom, but only about the mean properties of an assembly of similar atoms. One can, it is true, calculate the energy of a single atom in a certain state on the quantum theory. But that is only because the energy is the same for all atoms in this state, and the individual energy coincides with the mean. But if we consider the behaviour of the atom under external influences—*e.g.* incident light or electronic collision—we get a result that cannot be interpreted as showing that, for specific values of the phases, specific phenomena occur. We can only interpret the results of the calculation as follows: there is an assignable probability that the atom will do one thing, and an assignable probability that it will do any other.

We have a similar situation in optics. Classical optical theory yields, it is true, all interference phenomena in perfect accord with experiment. But the calculated intensity of light at a given point does not represent the actual intensity. The classical wave-field clearly only gives the probability that a quantum will reach the point. Moreover, one can find waves accompanying a material corpuscular beam which in some respects bear the same relation to the corpuscles as the light waves to the quanta. Here again we see the purely statistical nature of the present quantum theoretical laws.

We shall therefore direct our attention, not to the discrete, discontinuous details, but to the corresponding probabilities. The introduction of these probabilities brings us formally back to continuous variables, and thus, in a very important respect, to classical terms. We are therefore led to suppose that there is a principle of determinism for these continuous probabilities which is not very different from the classical principle. This is, in fact, the case, but in a somewhat more abstract way than in the classical theory.

It is known that Schrödinger, independently and by methods of his own, was able to give a formulation of the quantum theory which turned out to be mathematically equivalent to the matrix theory based on Heisenberg's ideas. He thus discovered mathematical relationships in the quantum theory, which had not before been explicitly developed. These were, it is true, implicitly involved in the matrix theory; but their formulation represents an important addition to quantum mechanics.

In connexion with these formulæ, Schrodinger also tried to develop a new physical basis for the quantum theory. His interpretation differs fundamentally from that of Planck, Bohr, and Einstein, from the classical quantum theory based on stationary states and quantum jumps. In it he tried to return to quasi-classical conceptions, in which there were no longer any discontinuities, and in which, therefore, the classical principle of determinism was still valid. All other scientific workers, however, who had taken part in the development of quantum mechanics, were unable to accept these speculations of Schrödinger. They were sure that the new conceptions would have to be interpreted physically in close analogy with the older notions of stationary states and quantum jumps, and with Heisenberg's theory; and that Schrödinger's relations would, like those of the matrix theory, have to be interpreted statistically. A particularly clear and satisfactory formulation of the statistical interpretation of Schrödinger's theory has been given by Born, and in what follows I shall base my argument on this.

The essential purport of Schrödinger's theory is this: that quantum mechanical laws, which were given in the matrix theory as a system of infinitely many equations with infinitely many unknowns, can instead be expressed by quite ordinary differential equations. Formally, this takes us back very close to the classical theory. Born's answer to the question as to how it is possible to represent anything in the discontinuous confusion of quantised atomic processes by differential equations, is that the function which is to satisfy the differential equation is a probability.

We shall now consider more closely this probability function, and try to make clear the analogy with the classical situation. Consider a mechanical system of two particles and six degrees of freedom; let the continuous co-ordinates of the particles be x_1, x_2 to z_1, z_2. We now construct a space more or less like the classical phase space, but with only half as many dimensions: a configuration space. In our example it is a six-dimensional space with the co-ordinates x_1 to z_2. We can represent the state of the system when it has specified co-ordinates and arbitrary momenta by a point in this space, which we shall call the system-point. Classically the system-point would describe a certain trajectory. But we cannot know beforehand, if we observe it at a given time at a given place in the space, how it will move, for the system-point only tells us the co-ordinates, not the momenta, of the two particles. All one can determine is the probability that the point will move in a given direction.

In the classical theory we can translate this statistical prediction into an exact one, since we can observe not merely the position but also the velocity of the system-point. But, according to Pauli, this is just the point where quantum and classical theory differ. If we can observe the co-ordinates of a quantum mechanical system—and here we use *co-ordinate* in a generalised sense, so as to include, say, the energy or the quantum numbers—then the momenta conjugate to these co-ordinates are intrinsically not observable. All we can do, therefore, is to take over the statistical problem from classical mechanics, and probably derive the solution from Schrödinger's differential equation. I say *probably*, because considerations which follow out these speculations are not yet completed.

The following question, however, which is closely connected with the one we have been considering, *can* be regarded as solved by the work of Born and Pauli. Suppose we know the energy and quantum numbers of our system—or, more generally, suppose we know the probability that the system is in any of the stationary states; what is the probability that the system-point is at a given place in the configuration space? We can answer this question at once if we know the Schrödinger wave function.

This Schrödinger function—a function of the six variables x_1 to z_2 and the time—satisfies Schrödinger's fundamental differential equation. For this probability function we can again formulate a principle of determinism. For this, of course, we have to take a box, not in ordinary space, but in the six-dimensional configuration space. Then the principle is precisely the same as in the classical theory, except that in place of the measurement of the field inside and on the boundary of the box we must now write the measurement of the Schrödinger probability function.

To recapitulate: classical physics described the world in terms of quantities continuously propagated in space and time. The quantum theory describes the world in terms of an abstract, many-dimensional configuration space, and the number of dimensions is proportional to the total number of particles in the world. In this abstract space we have again the propagation of continuous quantities; but these no longer tell us directly about the single atomic phenomenon, but rather about the probabilities of quantum processes. Determinism—not as a metaphysical distinction from chance, but in the physical sense explained above—has the same formal validity in both theories.

Of course, one can transform the quantum theoretical laws back to ordinary space, but their form is then very complicated, for the abstract space leads to the most suitable formulation of the problem. But one can still say that the complicated 3-dimensional predictions justify, roughly, what I said before—that in the mean the old 3-dimensional determinism still holds.

We have seen how it is possible, by the use of averages and probabilities, to eliminate the elementary discontinuities in physical processes, and to find relations which can be formulated mathematically by the customary methods of classical physics, methods adapted to the study of intrinsically continuous quantities. In this respect quantum mechanics constitutes a more precise version of Bohr's correspondence principle. Bohr always (it will be remembered), even in the zenith of our belief in integers, insisted that we try to establish a formal analogy with classical theory by a consideration of mean values.

Now, however, we shall return to the problem of the discontinuous elementary phenomena; we shall consider the question of how much we can say about these phenomena, granted that we can find the solution of any problem in averages, whatever their formulation. The answer to this question is not nearly so simple as one might expect; and I should be guilty of a very superficial treatment of my subject if I were not at least to point out some of the difficulties that occur in connexion with it.

Let us first of all examine the matter from the empirical point of view. One might suppose that experiments would in no case give us anything but average values. An interesting lecture given by Prof. Zernicke last summer on the Brownian movement, and in particular on the researches of Ising in Sweden, showed clearly the impassable limits to an improvement of the technique of physical measurement. It is impossible to increase the accuracy of a galvanometer, for example, beyond a certain assignable limit; it is impossible because of the Brownian movement in all parts of the apparatus. The needle, the fibres, the housing, the surrounding air, all consist of atoms in irregular thermal agitation; and the current that passes through the galvanometer consists of electrons, and therefore shows irregular variations of intensities, which can only be statistically computed and limit the efficiency of the instrument in an analogous way. When we remember that this is the case with all our apparatus, and that it all 'rattles about' in this way, we may be tempted to think that the experimentalist is quite as incapable of observing elementary processes as the quantum theorist is of predicting them. But there is a drastic method of avoiding Brownian movement. The theorist gives the simple recipe: make the experiments at the absolute zero. Luckily, experimentalists have discovered an equivalent but less uncomfortable way. By working with particles which have a vast store of energy, *e.g.* a fast α-particle, they make the thermal agitation of the atoms negligible. And we can, in fact, largely because of the work of C. T. R. Wilson, actually observe the fate of a single α-particle, follow its trajectory, and determine the moment when the trajectory ends in a quantum jump.

The time of a single quantum jump is thus under certain conditions a measurable quantity. What predictions can our theory make on this point? The most obvious answer is that the theory only gives averages, and can tell us, on the average, how many quantum jumps will occur in any interval of time. Thus, we must conclude, the theory gives the probability that a jump will occur at a given moment; and thus, so we might be led to conclude, the exact moment is indeterminate, and all we have is a probability for the jump. But this last conclusion does not necessarily follow from the preceding one; it is an additional hypothesis. It is this hypothesis which Bohr, Kramers, and Slater tried to carry out in their theory of radiation. They realised quite clearly that this hypothesis must leave the conservation of energy as only a statistical theorem. This conclusion, of course, was disproved by the beautiful experiments of Geiger and Bothe and of Compton. We can now assert that if an atom emits light, and that if this light is propagated, unhindered by interference, to another atom, where it is absorbed, then the quantum jump of the absorbing atom occurs after a time which corresponds exactly to the distance between the atoms. Thus we see that, in some cases at least, the time of a quantum jump is determined.

One might be tempted to say: the time is determined in so far as its determination is required for conservation of energy—and no further. But this two-sided explanation is too indefinite to be of any use in complicated cases, *e.g.* where interference occurs. Another method of overcoming this difficulty was tried some time ago by Wentzel: since in our example the absorption is fully determined by the preceding emission, we could regard the two processes together as a single quantum process, and then hope that such processes would be statistically independent of each other. But this way, too, does not seem to lead to any simple formulation.

It is thus very significant that in Pauli's above-mentioned formulation nothing is said about the probability of a transition—for we saw that this could not lead to independent probabilities. What the theory does specify is the probability that the system-point be at a given place in the configuration space. One might therefore hope that these considerations would lead us to independent elementary physical probabilities.

Although we can in principle compute all probabilities on the quantum theory, a very serious problem still remains unsolved. For definiteness let us take a simple example. Let us throw two dice; and let us observe empirically that a 1 and a 3 occur together just as often as a 4 and a 5, and twice as often as two 2's, and so on. Now if we had a theory which made it possible to compute these probabilities in some very complicated and abstract way, we might be satisfied. But we are really only satisfied when we can reduce the theory to this form; for each die each of the six faces is equally probable; and the dice are statistically independent. Only when we see this do we feel that we really understand the matter.

Now, for the dice we clearly should never think of using any other theory than the one just given. But in the quantum theory the matter is different: we can at present compute all probabilities; but we cannot understand any of them. We could only say that we understood them if we had translated the calculations in configuration space into the following terms: In some cases there is no condition on what happens; either this or that can happen; they are equally likely, and what happens in one case has nothing to do with what happens in others.

In other words, we must reduce the quantum theoretical probabilities to independent elementary probabilities. Only then can we say that we really understand the laws; and only then can we tell under what conditions the time of a transition is determined. Only then can we know exactly what is causally determined, and what is left to chance.

In conclusion, let me try to bring out one more point. We have just been taking for granted that the future analysis of quantum theoretical probabilities would lead to the result that certain elementary processes were not determinate, and could happen equally probably in a variety of ways. But in fact that is not at all self-evident. The circumstance that quantum laws are laws of averages, and can only be applied statistically to specific elementary processes, is not a conclusive proof that the elementary laws themselves can only be put in terms of probability.

We can thus put in this final form our question, "Does modern physics recognise any complete determinism?"—a question which we have seen to split up into several distinct ones. Will the elementary laws for which we are looking be laws of determinism or of probability? Will it ever happen that the time of a quantum jump is undetermined?

Probably we shall find that an incomplete determinism, a certain element of pure chance, is intrinsic in these elementary physical laws. But, as I have said, a trustworthy decision will only be possible after a further analysis of quantum mechanics on the lines laid down by Born and Pauli. Perhaps I might add that pertinent considerations have been recently carried through in Copenhagen, and here in Gottingen, in what, I think, is a very promising way.

The Lister Centenary Celebrations in London.

On April 5, 1827, there was born at Upton, in Essex, one who was destined to achieve more for the happiness of mankind than was vouchsafed to almost any other human being. Joseph Lister was the fourth child and second son of Joseph Jackson Lister, a prosperous wine merchant and also an eminent scientific worker, and fellow of the Royal Society, to whom we owe the production of the achromatic lens. He studied medicine at University College, London, and in 1852 took the M.B. degree and became also a fellow of the Royal College of Surgeons.

Acting on Prof. Sharpey's advice, Lister then went to Edinburgh, where he became closely associated with the famous surgeon James Syme, and in 1856 he married Agnes, Syme's eldest daughter. In 1860 he was appointed professor of surgery in the University of Glasgow, a post which he held for nine years, only leaving when he was elected to the Edinburgh professorship. In 1877 he was appointed to the chair of clinical surgery at King's College, London, and held this post until 1893. In 1883 he was made a baronet. In 1895 he became president of the Royal Society, and during his tenure of this office, was created a peer, on the occasion of Queen Victoria's second jubilee. At the time of King Edward's coronation he became a member of the Order of Merit. In 1908 he retired to the small seaside town of Walmer, in Kent, where four years later, on Feb. 10, he passed peacefully away, at the age of eighty-four. Lady Lister had predeceased him by some nineteen years.

This bald sketch of Lister's life will enable readers to follow more clearly the account which follows of the celebrations during the Lister centenary week in London, in which the speakers dealt with the various aspects of his life and work. For further details those interested may be referred to the chapter on the Life of Lord Lister in the Handbook of the Lister Centenary Exhibition at the Wellcome Historical Medical Museum.[1] The Glasgow period is dealt with by Sir Hector Clare Cameron,[2] and in the centenary contribution entitled "Lister and the Lister Ward in the Royal Infirmary of Glasgow,"[3] wherein accounts are given of the beginnings of antiseptic surgery and of the fruitless efforts made by scientific men the world over to save the Lister ward from demolition: the Edinburgh period is described in interesting detail by Dr. J. R. Leeson.[4]

The centenary celebrations commenced in London on Monday, April 4, when about a hundred delegates from all parts of the world were received by the King at Buckingham Palace. An address was presented by Sir Ernest Rutherford, president of the Royal Society, to which His Majesty replied. In the afternoon the Listerian Society held a meeting at King's College Hospital, with Mr. Arthur Cheatle in the chair. Sir Watson Cheyne, in the course of his address, said that the outcome of Lister's work was perhaps more widespread than that of any of the great statesmen, generals, philosophers or religious teachers, and its influence on mankind was not limited to any country or race. Sir Watson described how he himself, with a few other chosen associates, accompanied Lister from Edinburgh to King's College Hospital as apostles of the new methods in surgery. Like all pioneers, Lister met with much opposition in promulgating his views, and London was probably one of the last places in the world to accept them. The speaker referred also to Lister's conscientiousness, both in the treatment of his patients and in his lectures: for the latter he endeavoured, by his own experiments, to prove any points which appeared to him doubtful. The difficulties in advising treatment were greatly enhanced by the fact that only some surgeons practised antisepsis; thus an operation which might be justifiable, performed antiseptically, would be contra-indicated if the additional risk of sepsis had to be run.

In the evening a reception was held at the Royal Society of Medicine, when Sir St. Clair Thomson gave an address entitled "A House Surgeon's Memories." He said that Lister achieved more for mankind than all the surgeons from the beginning of history. For centuries the results of surgical wounds had scarcely improved at all: but Lister's teaching has saved more lives than all the military heroes of all the ages have destroyed. Sir St. Clair was associated with Lister at King's College Hospital; at his inaugural lecture he described experiments showing that neither milk nor blood had any inherent tendency to putrefaction, and if drawn under what we should call 'sterile' conditions, would remain free from putrefaction indefinitely. Lister's classes were strangely neglected by the students, probably owing to the fact that his work did not find favour with the examiners of the period, so that his teaching was of little use in helping a man to pass his examination. London was not backward in demonstrating that a prophet was not without honour except in his own country. But in ten years' time, with a new generation of surgeons springing up, Lister's technique had become widely followed. Sir St. Clair referred also to his scientific spirit. In 1875, Queen Victoria, to whom only one side of the question had been presented, wrote to Lister asking him to take action to suppress vivisection. Lister wrote to the private secretary as follows: "I should deeply regret that I cannot see my way to comply with this request, were I not persuaded that my duty so would not promote the real good of the community, which I know to be Her Majesty's only object in the matter."

On Tuesday, April 6, the delegates to the centenary celebrations were received by the Prime Minister in the Great Hall of the British Medical

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[1] Lister Centenary Exhibition at the Wellcome Historical Medical Museum: Handbook, 1927. (The Wellcome Foundation, Ltd., London.)

[2] "Centenary of Lord Lister, 1827-1927. Reminiscences of Lister and of his Work in the Wards of the Glasgow Royal Infirmary, 1860-1869. By Sir Hector Clare Cameron. (Glasgow University Publications, 6.) Pp. 45+8 plates. (Glasgow: Jackson, Wylie and Co., 1927.) 1s. net

[3] "Lister and the Lister Ward in the Royal Infirmary of Glasgow: a Centenary Contribution." Pp. xvi+152+28 plates. (Glasgow: Jackson, Wylie and Co., 1927.) 12s. 6d. net.

[4] "Lister as I knew Him." By Dr John Rudd Leeson. Pp. xii+12+7 plates. (London: Baillière, Tindall and Cox, 1927.) 8s. 6d. net.

Association, Tavistock Square. Sir Ernest Rutherford was in the chair and was accompanied by Mr. R. G. Hogarth, president of the British Medical Association. Sir Ernest, in the course of a few introductory remarks, said that it was not necessary to be a specialist to recognise the debt the whole world owes to Lister's discoveries and his single-minded devotion to the cause of suffering humanity. Mr. Baldwin recalled that it was two years after Lister came to London, and before he had obtained that recognition which was afterwards lavished upon him, that at an international congress in Amsterdam, he was greeted by the chairman in these words: "Prof. Lister, it is not only our admiration which we offer you; it is our gratitude and that of the nations to which we belong." These words were echoed years later, not by an Englishman but by an American, at a dinner of the Royal Society, when Mr. Bayard, the American Ambassador, in proposing Lister's health, said: "My lord, it is not a profession, it is not a nation, it is humanity itself which with uncovered head salutes you." The Prime Minister said that they had come to greet the memory of a great master workman in his own craft, the man who pursued his science empirically and who also, by applying newly discovered knowledge to practical problems throughout his life, brought more relief and comfort to the human race than almost any man who has lived. At the same time, as a statesman he (Mr. Baldwin) felt he could pay tribute to Lister's character, his wonderful simplicity and integrity, for he was a man who loved the truth, gentle and filled with charity and self-devotion, a man with never a mean thought.

After the Prime Minister had greeted each delegate, Prof. Henri Hartmann of Paris and Prof. Max Ritter von Gruber, of Munich, spoke on the influence Lister's practice had on pathological and surgical science and practice in their own countries.

On Wednesday, April 6, a thanksgiving service was held in Westminster Abbey, in the morning, which was attended by the delegates, and by representatives of the Royal Society and of the Royal Colleges of Surgeons and Physicians. The service was conducted by Canon Nixon, and the Bishop of Birmingham, Dr. E. W. Barnes, delivered an address. He said that Lister owed much to his Quaker ancestry, and perhaps it was not fanciful to see in the ability of his father, and in a touch of Celtic imagination derived from his mother, the source of his genius. He certainly received in his home life influences which made his character the worthy servant of his genius. Throughout his life he retained the Christian faith of his childhood: at the time of his marriage he ceased to belong to the Society of Friends and became, like his wife, a member of the Scottish Episcopal Church. He combined the hope of personal immortality with faith in the goodness of the Creator, and when his life was drawing to a close, he publicly expressed his conviction that "there is no antagonism between the religion of Jesus Christ and any fact scientifically established." He was convinced of the power of goodness and was a loyal servant of the truth. Dr. Barnes continued by saying that man differs from all other animals in possessing a soul. Is it possible that, by virtue of the mental powers which set man apart, he will conquer disease and pain and thus, in the end, prepare the way for a Kingdom of God upon earth? Will medical and moral victories combine to make human life equal to human hopes? The achievements of great men give substance to our hopes, and we thank God, he said, for the example of a single-minded devotion to science which will inspire others to work for the welfare of the human race.

In the afternoon a meeting was held at the rooms of the Royal Society of Medicine, at which tributes were paid to Lister as physiologist, bacteriologist, and surgeon. Sir Ernest Rutherford was again in the chair.

Sir Charles Sherrington spoke on Lister as a physiologist. He said that Lister's first paper, published when he was twenty-five years of age, was on the "Contractile Tissue of the Iris," done with the microscope, which he used for the study of function rather than of form alone. It was only natural, considering the interest his father took in optical science, that young Lister should employ the microscope in his first research. His second paper was on the involuntary muscle cells of the skin, and it is of interest to note, in connexion with his later characteristics, certain expressions used in these papers, such as "the grand discovery of plain muscle cells" and "the beautiful muscle of the iris." These phrases throw light on the eagerness with which he threw himself into research. These papers reveal points in Lister's original nature: a catholic enthusiasm for research and a restless testing of authority by observed fact: in short, a fear of nothing except of missing the truth. Four years later, a further paper on involuntary muscle appeared, in which Lister proved, once again, its cellular nature; but this was the last on this particular theme: his interests had turned to surgery and pathology and his physiological research became merely collateral to the pathological studies engaging his main thoughts. His earlier work in this field was related to the problems of inflammation, and dealt with the nervous control of arteries and the inhibitory nature of certain visceral nerves; but after the year 1859 none of his work was directly related to physiology. Yet by means of his work on antisepsis and by the development of his surgical technique he enriched physiology with the contribution of enhanced means towards its own cherished aims. Without Lister's surgical principles, how could Pavlov have achieved his epoch-opening study of the digestive processes, or Ferrier initiated his work on localisation of cerebral function? How could the Toronto physiologists, barely four years ago, have bestowed upon diabetic sufferers that merciful remedy insulin? The experimentalist indeed owes to Lister an instrument of research the beneficent future of which the boldest imagination may well halt to set limit to. At the same time, while helping man to mastery over disease alike for animal and man, he contributed to free that necessary experimentation from the infliction of pain. Thus it is that through the years to come, after indeed the actual physiological papers may have become matter chiefly for the historian and antiquarian, Lister will still receive his meed of commemoration from the physiologist and experimentalist. It is therefore with peculiar gratitude that the physiologist brings his tribute of admiration and veneration to the memory of one great even among the greatest of the benefactors of humanity, Joseph Lister.

Prof. William Bulloch then gave an account of Lister as a pathologist and bacteriologist. The main part of the address covered the same ground as that of the article entitled "Some Aspects of Lister's Scientific Work," which Prof. Bulloch contributed to our issue on April 9, p. 531.

In the third and final address Sir Berkeley Moynihan paid an eloquent tribute to Lister as a surgeon. He said that seldom is a great discovery the product of one man's mind: in the work of other men it has ancestors—forerunners possessing one or more attributes the final and felicitous association of which within new work constitutes new truth. The claim may then arise that those who have revealed isolated and antecedent truths have priority in the final discovery. Such truths are, however, only progenitors, with no claim to be regarded as their own descendant—the new truth itself. Lister did for the craft of surgery what John Hunter had done for its science. When he first began his work, operations were few owing to the danger of putrefaction in the wound, followed in almost all cases by death. Even the simplest operation was a great anxiety to the surgeon, from the ever-present fear of suppuration developing. Lister's discovery was very gradual. His earliest surgical inquiries dealt with inflammation and the coagulation of the blood, but his chief interest lay always in the problem of the healing of wounds. He had arrived at the conclusion that the essential cause of suppuration in wounds was decomposition brought about by the atmosphere acting upon blood and serum retained in them, or upon portions of destroyed tissues, but since oxygen was considered to be the agent causing this putrefaction, it appeared hopeless to devise a method by which suppuration might be prevented. But when Pasteur had shown that putrefaction was caused by minute organisms suspended in the air, a method of prevention at once came to his mind, to apply to the wound some substance which would destroy the micro-organisms without injuring the body tissues. Still later he developed a method by which the organisms might be destroyed before they had even entered the wound. Around every step of his advance fierce controversy raged; the scepticism of early contemporaries was stupid, unimaginative, and petty. But the history of science frequently discloses this bitter opposition to new truths, as in the case of Harvey and Pasteur and other famous men. Lister's answer was unfaltering continuance in inquiry and experiment, with demonstration of his results. The heavily infected wounds seen during the War has enabled us to realise much more acutely the problems which confronted Lister at the beginning of his work, and has increased our admiration for the way he overcame them. Although Lister sought to destroy the organisms which might enter a wound, yet he was not blind to the natural resistance of the body's cells to infection, so that a natural step was the development of aseptic surgery in which organisms are prevented from entering a wound so far as possible, and any that do can then be dealt with by the body's own bactericidal forces. There is no real clash between 'antiseptic' and 'aseptic' methods, for no surgeon ever practised with success a method which omitted the use of agents for the destruction of organisms. The consequences of Lister's work were many and far-reaching: when the few operations which were practised in those days became safe it was obvious that others might be attempted, and thus has grown up the science and art of modern surgery. Ovariotomy was one of the first operations to be made safe; and once it was found that the abdomen could be safely opened, a vast field of usefulness was before the surgeon. The cranial and thoracic cavities then became accessible to surgical methods of treatment, so that nowadays almost all parts of the body can be safely submitted to surgical operation. Not the least of the debts we owe to Lister is the curability of cancer if complete surgical removal is practised in the early stages of the disease. We may almost claim that the full effect of Lister's work is now accomplished. The art of surgery is far in advance of the sciences on which its future progress depends. The great search must be for methods of applying new discoveries in other sciences to the study of disease.

To the honoured dead we raise our monuments; but Lister's living and enduring memorial is a great and even greater multitude of men, women, and children of every nation, of every race, of every creed, through his mercy and by the skill of his most gentle hand relieved from infirmity and suffering and sorrow and made for a time triumphant over death itself. It is immortal Lister we salute to-day, the supreme benefactor of mankind.

In concluding, attention must be directed to the Lister Centenary Exhibition at the Wellcome Historical Medical Museum in Wigmore Street. The collection was opened by Sir W. Watson Cheyne, in the absence of Mr. Wellcome, on the evening of Thursday, April 7. The most striking exhibit is probably the section of the old Lister Ward from the Glasgow Royal Infirmary, in which Lister practised his antiseptic system of surgery between 1861 and 1869. The furniture and fittings are from the Ward when it was demolished in 1924. The collection comprises an extensive and highly interesting series of exhibits relating to all aspects of Lister's life and work, including instruments and apparatus used by him, reproductions of various experiments performed by him, his diplomas and certificates, and photographs of those associated with him in his work.

Obituary.

DR. F. B. POWER.

DURING his stay in Great Britain, Dr. Frederick Belding Power made many friends among chemists, who will regret to learn of his death from heart failure in Washington on Mar. 30. He was born at Hudson, in New York State, in 1853, and at the early age of thirteen years was apprenticed to a local pharmacist. This direct connexion with pharmacy was continued up to 1874, when, after securing his diploma at the Philadelphia College of Pharmacy, Power went to Strasbourg, where he took his Ph.D. in 1880. Returning to the United States, he held, among other teaching appointments, the professorship of materia medica and pharmacy at Wisconsin University.

Among his fellow-students at the Philadelphia College of Pharmacy was Mr. Henry S. Wellcome, and when the latter established the Wellcome Chemical Research Laboratories in 1896, he invited Dr. Power to become the first director. From 1896 until 1914, Power and his assistants maintained a remarkable output of papers dealing mainly with the constituents of plants. Fellows of the Chemical Society will remember the occasions on which these papers were read, for the lecture table was always decorated with an extensive series of small glass bottles, each containing a specimen of one of the constituents isolated from the plant under discussion. Each bottle was labelled in Power's meticulously careful caligraphy, and the bottles were always arranged in the precise order in which the author would describe their contents. These ranged from simple fatty acids to the most complex of glucosides or alkaloids and all the solids were beautifully crystallised. Power belonged to the generation of chemists who were primarily interested in the isolation of the constituents of plants in a pure state, and his papers devote little or no attention to speculation on the origin of these substances or to their possible bearing on biological relationships, but they form a mine of information, upon which in due course bio-chemists interested in these things will be able to draw.

The work of Power and his collaborators, among whom Mr. Tutin and Mr. Barrowcliffe should be specially mentioned, has already borne fruit in at least one direction, for it is upon the results of their researches on the peculiar acids of chaulmoogra and hydnocarpus oils that the whole of the modern treatment of leprosy is based. Similarly, they did much to extend our knowledge of the distribution of sterols in plants, and in view of the recent discovery of the connexion between certain types of sterols and vitamin D, this work may prove of considerable scientific interest.

In 1914, Power returned to the United States, where he carried on similar work in the phytochemical laboratory of the United States Department of Agriculture. In the previous year he had been awarded the Hanbury Medal by a joint committee of the Chemical, Linnean, and Pharmaceutical Societies of Great Britain, an award peculiarly fitting for so untiring a pioneer in plant chemistry, and one which he regarded as not the least among the many of which he was the recipient.

DR. JOHN BROWNLEE.

THE unexpected death of Dr. John Brownlee, after an illness of little more than two days, has removed one of the very few highly trained research workers in the field of biological and medical statistics. Dr. Brownlee, who was in his sixtieth year, had been, since 1914, Statistician to the Medical Research Council and Director of the Council's Statistical Department at the National Institute of Medical Research. He was a graduate in arts, science, and medicine of the University of Glasgow, and obtained first-class honours in mathematics and natural philosophy. Before his appointment by the Medical Research Council he had held several important medical posts and successfully directed two large hospitals for infectious diseases.

Brownlee's scientific output was very large; he was the author of more than eighty separate papers. He was particularly interested in the study of periodicity in epidemic disease and, in a series of memoirs, applied the method of periodogram analysis to the data of all the important infectious diseases. Perhaps the most complete of these memoirs was that dealing with measles, which was published in the *Philosophical Transactions of the Royal Society* (Ser. B, vol. 208 and 209, 1917 and 1918). He was also intensely interested in the application to the phenomena of human physiology of physico-chemical laws; his numerous papers on this topic, and the zeal with which he sought to apply physico-chemical equations, led his very numerous friends to rally him on holding that the general law of life was a geometrical progression.

These subjects, however, by no means exhausted Brownlee's energies. Within the medical field his work on the epidemiology of phthisis and various more specialised papers upon infectious disease were important, while his contributions to the study of Scottish anthropology and archæology are noteworthy. His range of scholarship was extremely wide and his outlook philosophical. Valuable as have been his individual contributions to science, it is regrettable that he never carried out an intention he once formed of preparing a comprehensive treatise which would have given full scope for his powers. Dr. Brownlee has left a gap which it is impossible to fill, for he combined technical knowledge and wide intellectual culture in a way which is unfortunately rare in the younger generation of investigators.

News and Views.

The Imperial Conference of last year, at which the self-governing Dominions and India were represented, is to be followed by a Conference—the first of its kind—called by the Colonial Office, which will be attended by representatives of the non-self-governing Colonies, Protectorates, and Mandated Territories. Most of these dependencies will be represented by their governors or by a senior official, and officers of the specialised services who are on leave will be invited to be present at discussions of papers and addresses dealing with matters of particular concern to their several departments. The Conference will hold its first meeting on May 10. Its main object will be to secure more effective co-operation between the various Colonial governments in matters of general interest. The items for the agenda are grouped under the headings: (*a*) Questions of general administration; (*b*) economic questions covering trade and communications; (*c*) problems of technical services. In each of the three sections matters of particular interest to scientific and technical workers are down for discussion. Under (*a*) there should be an interesting interchange of views on "the relation of technical to administrative services," which is to follow a subject of particular significance to the Colonial services, the recruiting and training of Colonial civil servants. It would be a healthy sign if consideration of this subject were to embrace the principles governing the selection of Colonial governors themselves. Far too many men of high rank in the Navy or Army have been made governors of the dependencies of the Crown as a reward for past services of a character which often unfitted them for the essentially creative work of controlling the destinies of backward peoples.

It is to be hoped that due publicity will be given to the proceedings of this Conference. The papers dealing with such matters as "Recent Developments in Mechanical Transport," where the results of experiments with various types of trackless mechanical vehicles will be given; the progress and possibilities of "Civil Air Development" as affecting the various territories; and "Wireless Communications," should contain much information of value to technicians at home who are interested in these matters, apart altogether from their particular interest to home traders and manufacturers. Under "Problems of Technical Services" special emphasis is to be put upon the need and the means whereby to effect co-operation and exchange of information in research and technical matters. This subject, it will be remembered, assumed great importance at the last Imperial Conference. Most of the activities of the specialised services, health, agriculture, forestry, education, are to be dealt with, but it is to be regretted that no specific mention is made of the geological surveys or of the departments of mines. The number of Crown Colonies which maintain such surveys may not be large, but the activities of the existing surveys are sufficiently important to be brought to the notice of the Conference.

The new radio beam service to Australia was opened to the public on Friday, April 8. The messages are dispatched in London by the ordinary Wheatstone machines and pass automatically by land line to the sending station at Grimsby. They are then sent by a beam of radio waves on their 10,000-mile journey to the Australian receiving station at Rockbank. Finally they travel by land line into the receiving office at Melbourne. The messages coming from Australia to Great Britain pass from Melbourne to Ballan, a distance of 55 miles; then from Ballan to Skegness, and finally to London by land line. It is interesting to learn that it is possible to direct the beam either eastward over Europe and Asia, or westward over America and the Pacific. In the reverse direction this can also be done from Melbourne. The route is chosen according to the time of day. It is found that radio signals travel better at night, and so the darker of the two paths is chosen. The signals take one-eighteenth of a second to travel from the transmitter on the one continent to the receiver on the other. The speed of transmission is governed only by the limitations of the transmitting and recording instruments used. The Marconi Company contracted to provide a system which would work at the rate of 100 words per minute, in both directions at once, for seven hours a day. The performance largely exceeds the minimum specified. The working has been carried out for 18 hours out of the 24, and for several hours the speed has been at the rate of 200 words a minute. On test also the speed was worked up to 325 words a minute. It is stated that the Indian and South African radio beam links will be ready for tests in a few weeks' time. The Canadian beam link has been working since last October.

Mr. H. Frankfort's preliminary summary of the results obtained from excavations carried out by the Egypt Exploration Society during the past winter at Tell el-Amarna, which appeared in the *Morning Post* of April 4 and 5, suggests that his report, when published in full, will prove of exceptional interest in the light it will throw on the everyday life of the ordinary individual. One part of the work has been directed to the investigation of a suburb of the city founded by Aken-aten, which was populated, not to say over-populated, by members of the middle and lower classes. It has revealed the plan and domestic economy of private residences ranging in size from the 'comfortable,' down to the mere hovel. It has been found, for example, that in the larger houses the kitchen was situated at some distance away from the main structure; in the smaller it was erected against the wall of the building, and access to the dining-room was provided by means of an entrance from one of the loggias, which were a characteristic of these residences to secure coolness. Some interesting and instructive examples of bed- and bath-rooms were found in a state of good preservation. In houses even of this size the domestic

The Mellon Institute of Industrial Research, University of Pittsburgh, is primarily a technological experiment station, but the need for fundamental scientific research as a background and source of stimulus for research on behalf of industry has always been recognised. During the past five years the Institute has been giving an increasing amount of attention to the encouragement and support of research in pure chemistry, and has been progressively successful in arranging for funds for investigations not suggested by industry, but planned within the Institute for the study of basic problems. Since 1922 Dr. Leonard H. Cretcher has been in charge of the Institute's research in pure chemistry, and has contributed a number of papers to the literature. Hitherto these investigations have been conducted in accordance with the Institute's fellowship system, but the Director, Dr. E. R. Weidlein, has recently announced the establishment of a definite department of research in pure chemistry, with Dr. Cretcher as its head. Dr. Cretcher will supervise all the Institute's purely scientific studies in chemistry, and will also act as an adviser to those holders of industrial fellowships who are carrying on research on specific problems in synthetic organic chemistry. The new department will be operated as an integral part of the Institute and will be sustained by institutional subsidy. Dr. Cretcher will be assisted by Dr. William L. Nelson as fellow in pure chemistry. Dr. Nelson was formerly a member of the staff of the department of chemistry of the University of Pittsburgh.

Opinions 91-97 rendered by the International Commission on Zoological Nomenclature have been published by the Smithsonian Institution in its Miscellaneous Collections. To the Official List of stable generic names there have been added, as fulfilling all requirements of the rules, the names of 35 Mammalia, 9 Reptilia, 3 Amphibia, 4 Pisces, 5 Tunicata, 17 Mollusca, and 2 Protozoa. The following 12 names of Pisces, now current, have been added to the same list by suspension of the rules (as [illegible] names), with the genotypes as given in parentheses: *Conger* Cuv., 1817 (*Muræna conger* L.); [illegible]*regonus* Linn., 1758 (*Salmo lavaretus* L.); *Eleotris* [illegible]loch and Schneider, 1801 (*gyrinus* Cuv. and Val.); *Epinephelus* Bloch, 1792 (*marginalis* Bloch); *Gymnothorax* Bloch, 1795 (*reticularis* Bloch); *Malapterurus* Lacépède, 1803 (*Silurus electricus* L.); *Mustelus* Linck, 1790 (*Squalus mustelus* L. [= *Mustelus lævis*]); *Polynemus* Linn., 1758 (*paradiseus* L.); *Sciæna* Linn., 1758 (*umbra* L. = *Cheilodipterus aquila* Lacép. restr. Cuv. 1815); *Serranus* Cuv. (*Perca cabrilla* L.); *Stolephorus* Lacép., 1803 (*commersonianus* Lacép.); *Teuthis* Linn., 1766 (*javus* L.). Conchologists will be delighted or dismayed to learn that the *Museum Boltenianum* (1798) is accepted as nomenclatorially available. With like diversity of feeling entomologists will take note that the "generic" (?) names in Hübner's "Tentamen" (1806) are ruled out—first, as not published; secondly, as *nomina nuda*. At any rate it is good to have these long-controverted questions authoritatively settled.

In the *Quarterly Review of Biology*, vol. 1, No. 4, Dr. Raymond Pearl publishes an interesting comparison of the prices charged for scientific books, as received in the United States from various countries. The most expensive are books first manufactured and published in Great Britain and then published in the United States by an American branch of the original firm. Next come those published in various unnamed countries, and then the books published in England and directly imported into the United States. It appears that the cost of running a branch in America adds 20 per cent. to the price of an English book; but this includes duty. American books published in the United States are only 12¼ per cent. cheaper than books published in England; but German books are 10 per cent. less, and this is rather surprising in view of recent complaints that certain German publishers have been making a corner and forcing up prices. French books, thanks to the failure of their publishers to keep pace with the franc, have averaged little more than a quarter the price of English books. In comparing French and German books with English and American, it should be remembered that the former are generally in paper wrappers and the latter generally cased.

John E. Teeple, consulting engineer, New York City, has been awarded the Perkin medal by the American Section of the Society of Chemical Industry for "significant scientific, technical and administrative achievements, particularly the economic development of an American potassium industry at Searles Lake, California." This medal is awarded "annually to the American chemist who has most distinguished himself by his services to applied chemistry," and was founded in 1906 at the time of the fiftieth anniversary of the coal-tar discoveries, the first medal being awarded to Sir William H. Perkin himself.

Mr. Hugh C. Sampson, formerly Director of Agriculture, Madras, has been appointed economic botanist at the Royal Botanic Gardens, Kew. This appointment has been made possible by a grant of £4000 for five years from the Empire Marketing Board, through the Ministry of Agriculture and Fisheries. The object of the grant is to promote that co-operation of Kew with the Dominions and Colonies which has already proved of great value in the introduction of new staples and the development of natural vegetable resources in new territory. Part of the grant will be available for sending out botanical collecting expeditions. Since his retirement, Mr. Sampson has been engaged in research on cotton and other economic products in Nyasaland under the Empire Cotton Growing Association.

The fourth International Congress of Theoretical and Applied Limnology is to be held at Rome in September 1927; the exact dates and details of the programme are to be published later. It is proposed to organise limnological excursions around Rome and the regions of central and northern Italy and Naples, while a Limnological Exhibition will be held in Rome and a Fishery Exhibition in Como. Intention to be present and titles of papers proposed to be presented should be communicated without delay to the Organising Committee of the Congress, R. Laboratorio Centrale di Idrobiologia, Via Tiburtina, Roma 38.

A year ago the "Sanitation Supplements" issued with the *Tropical Diseases Bulletin* were discontinued and replaced by a monthly *Bulletin of Hygiene*, for the review of the literature of public health and preventive medicine, of which we have received No. 1 of vol. 2, 1927. It contains summaries and reviews of publications on all branches of public health and preventive medicine, and is intended to meet more particularly the needs of Britain overseas. The Bulletin is issued by the Bureau of Hygiene and Tropical Diseases, 23 Endsleigh Gardens, W.C.1, at the subscription price of 21*s*. per annum.

The latest catalogue (No. 493) of Mr. F. Edwards, 83A High Street, W.1, is devoted to works relating to Canada and Arctic discovery. Particulars of nearly 600 volumes, maps, drawings, etc., are given. The catalogue is to be had free upon application.

We have just received from Messrs. Bernard Quaritch, Ltd. (11 Grafton Street, London, W.1), a copy of Catalogue (No. 407) of upwards of 1900 works on zoology, geology, and palæontology. The list should be of very great interest to librarians and others, seeing that it gives particulars of important publications many of which are of extreme rarity.

Applications are invited for the following appointments, on or before the dates mentioned:—An analyst at the Building Research Station of the Department of Scientific and Industrial Research—The Director, Building Research Station, Bucknall's Lane, Garston, nr. Watford (April 25). An advisory officer on farm economics under the Board of Agriculture for Scotland—The Secretary, Board of Agriculture for Scotland, York Buildings, Queen Street, Edinburgh (April 30). A bio-chemist at the General Hospital, Birmingham—The House Governor of the Hospital (May 2). An assistant demonstrator in physics (woman) at the Royal Holloway College—The Principal, Royal Holloway College, Englefield Green, Surrey (May 7). A laboratory assistant in connexion with the Imperial Bureau of Entomology, for work relating to living insects—The Assistant Director of the Bureau, 41 Queen's Gate, S.W.7. A laboratory attendant in histology at University College—Prof. J. P. Hill, University College, Gower Street, W.C.1. A woman lecturer in geography and science at the Truro Diocesan Training College—The Principal. A lecturer in geography at St. Mary's Training College, Strawberry Hill, Middlesex—The Principal. A male laboratory assistant for a biochemical laboratory—The Wellcome Physiological Research Laboratories, Beckenham. A professor of agriculture, and lecturer in dairy bacteriology, dairy technology, dairy chemistry, dairy engineering, and dairy accountancy and economics at the University College, Cork—The Secretary.

Our Astronomical Column.

Comets.—Comet Comas Sola, 1926 *f*, is still well placed in the evening sky. Several observers have noticed a short tail.

The following photographic observation is by F. J. Hargreaves, measured by G. Merton:

U.T.	R.A. 1927·0.	N. Decl	Mag.
Mar. 23·8729	4h 36m 26·67s	30° 27′ 45·5″	12·5

It had a central condensation, 5″ in diameter: ephemeris for 0h:

	R.A.	N. Decl.	log Δ.
Apr. 14.	5h 36m 6s	32° 41′	0·305
22.	5 59 56	33 3	0·319
30.	6 24 6	33 14	0·332

Mr. B. Strömgren has revised the orbit of Stearns's comet, using observations until Mar. 31, and obtains:

$$\begin{array}{ll} T & 1927\ \text{Mar. } 20{\cdot}2338\ \text{U.T.} \\ \omega & \left.\begin{array}{l} 10^\circ\ 38'{\cdot}63 \\ 214\ \ 36\ {\cdot}67 \\ \ \ 87\ \ 33\ {\cdot}38 \end{array}\right\} 1927{\cdot}0 \\ \end{array}$$

Ω

i

$\log q$ 0·56631

It has the fourth largest perihelion distance known.

Ephemeris for 0h.

	R.A.	N. Decl.
Apr. 13.	14h 57m 9s	4° 41′
21.	14 49 59	7 42
29.	14 42 20	10 37
May 7.	14 34 31	13 18

The Detonating Meteor of Oct. 2, 1926.—In a reprint from the *Meteorological Magazine* (Dec. 1926 and Jan. 1927), Mr. F. J. Whipple has detailed observations made to investigate the velocity of sound transmission from meteor observations, as *it seems possible that the temperature of the air* may materially affect the rate of motion of sound waves.

The great Yorkshire meteor of Sept. 6, 1926, which gave a loud detonation, promised an opportunity for such inquiries, but unfortunately the observations were not of desirable accuracy.

Another fireball appeared on Oct. 2 moving up from south to north over the Channel, west of London, and on to Hertford. An appeal for data was mad through the medium of the Air Ministry, and 70 responses were received at the Kew Observatory.

The evidence from the Yorkshire meteor convinc Mr. Whipple that the thunder-like noise was produc by the mere passage of the meteor through the ai The sharp detonation of the meteor of Oct. 2 ha a similar origin. Mr. Whipple remarks that Dr. Wegener had previously formed these conclusions from his study of the fireball of April 3, 1916. "Wegener points out the analogy with the noise produced by the passage of a shell fired from a big gun. *It is well known that a projectile moving* through the air with a velocity exceeding that of sound makes a wave like the bow-wave from a ship. This wave when it reaches an observer is heard as a sharp crack. The crack is followed by a rumbling noise which may be attributed to the irregularities in the aerial disturbance. The nature of these ballistic waves is expounded at length in a recent work by Prof. Ernest Esclangon, the pioneer of sound-ranging."

"As the meteor of Oct. 2 was moving about 70 times as fast as sound, the ballistic wave must have taken the form of a very sharp cone, nearly a cylinder. That sound was not heard beyond the end of the meteor's track may be analogous to the fact that the ballistic wave from a shell is not heard behind the gun."

Research Items.

NIUE (SAVAGE ISLAND).—As the result of seven months' field work in Niue, Mr. Edwin M. Loeb has collected evidence relating to the ancient customs, history, and traditions of the island which has been published as Bulletin 32 of the Bernice P. Bishop Museum, Honolulu. The population of Niue has been decreasing steadily since early missionary days, but the decline is now said to have run its course. During the year 1922 the deaths were 21·69 per thousand; the births 26·18. One of the prominent features of its culture is the division of the island into endogamous hostile moieties—a division which it is fairly safe to conclude is due to separate migrations. Historical traditions record three such migrations; minor differences of language, mythology, and physique still appear between the two ends of the island, and these were probably much greater in prehistoric times. The most important piece of evidence, however, is the difference in physique between the inhabitants of Motu and Tafiti. The people are undoubtedly of Polynesian stock. They lived under very primitive conditions, *i.e.* their political and social organisation was far less highly differentiated than that of other Polynesian peoples. Not only was a well-developed system of government lacking; but also the people themselves were not grouped according to crafts and occupations. There was no actual priestly class, and to the lack of power in the priestly class may be due the absence of the attribution of divinity to the ruling classes, of the taboo on women, and of the caste system imposed on the common people—features of Polynesian culture which developed at a relatively late date. There is also a lack of lengthy genealogies and of a well-developed stock of mythologies. Probably Niue was settled at an early date and, owing to its isolation, preserved its primitive institutions long after its neighbours had been converted to theocratic rule. It perhaps represents an archaic type of social organisation once common to all Polynesian peoples.

MIDDLE AMERICAN ARCHÆOLOGICAL RESEARCH.—In Year Book No. 25 of the Carnegie Institution of Washington, which covers the year 1925–26, Dr. Sylvanus G. Morley reports on the work of archæological exploration in Central America which is being carried on under the Institution. This is becoming of increasing importance as the excavation and preservation of the Maya site of Chichen Itza progresses. This work is fully described by Dr. Morley and Mr. E. H. Morris in dealing with the Temple of the Warriors and the North-west Colonnade. Among a further number of noteworthy examples of Maya art, special mention is made of examples of painting in which the colours, having been shielded from light and air, have been preserved in a remarkable manner. These, with others which have come to light, serve to show the importance of colour rather than of relief in these examples of Maya artistic technique. Important as this work is, it is overshadowed by the interest of the expedition of the Institution to Coba and also to Chetumal Bay in Yucatan, where the date inscription discovered by Dr. T. W. Gann, and giving the date A.D. 333, was examined. At Coba, the discovery of the site Macanxoc with eight Initial Series on May 24 constitutes one of the most important contributions to Central American archæology of the last five years. It practically trebles the Initial Series known from the Peninsula of Yucatan, and promises to throw a flood of light on the early history of the country. The dates of these series run in ten-year periods from A.D. 354 to A.D. 413. Two other monuments of which the inscriptions are illegible probably completed the sequence. The significance of Macanxoc lies in the fact that the latest date antedates the earliest date at Chichen Itza by more than two centuries, and pushes back the discovery of Yucatan a century earlier than the date for that event given in the Books of Chilan Balam.

FRESHWATER EELS IN JAVA.—An interesting addition to our knowledge of the distribution of freshwater eels has been made by Dr. H. C. Delsman in Java (*Treubia*, vol. 9, 4; 1926, and *De Tropische Natuur*, No. 10; 1926). The work was undertaken in response to a suggestion of Dr Johs. Schmidt in his recent survey of the freshwater eels of the Indo-Pacific Region, that if zoologists in Java would study the distribution there, much light would be thrown on the problem. In the Indo-Malayan area, *i.e.* the shallow sea surrounded by the Malay Peninsula, Cochin China, and the islands of Sumatra, Borneo, and Java, Dr. Schmidt noted the scarcity or absence of these eels, whereas they were abundant all round this region. He assumed that the larvæ of the Pacific species of Anguilla are inferior in migratory power to the Atlantic species and that they are unable to migrate through shallow water, and so are only found in numbers on the coasts facing deep water. Dr. Delsman's investigations resulted in a complete confirmation of Dr. Schmidt's conclusions. He found two species of freshwater eel common in Java, the mottled *Anguilla mauritiana* and the smooth *A. bicolor*, called 'dog-eel' by the natives and considered by them 'unclean' for food. They were present in all the rivers of the south coast and on the east and west as well, but were absent from the rivers of by far the largest part of the north coast. The suggestion is made that the development of the tropical species is accelerated by the higher temperature, so that the distance covered by the larvæ during their migration must be shorter than in the cooler seas. An excellent map of Java is given showing the extent and results of the survey.

THE INSECT FAUNA OF THE LESSER-KNOWN HAWAIIAN ISLANDS.—Changes in the fauna of the Hawaiian Islands through the demolition of native forests and the extension of cultivation have resulted in the extermination of certain of the endemic insects. At the same time, the maritime importance of Honolulu as 'the cross roads' of the Pacific has facilitated the entry through commerce of many alien species. In view of this process of subtraction and addition that is still altering the indigenous fauna to-day, the foresight of those Englishmen who inaugurated the "Fauna Hawaiiensis," and saw it through to completion, becomes increasingly evident. This work is the scientific basis for all subsequent progress in Hawaiian entomology but, at the time of its completion, the fauna of certain of the small outlying islets, north-west of the Island of Kauai, was little known. In 1923 the *Tanager* expedition made a biological survey of these remote areas and also of the still more distant Johnston and Wake Islands. A report on the insects by Mr. E. H. Bryan, jun., and collaborators, has recently appeared as Bulletin 31 of the Bernice P. Bishop Museum, Honolulu (1926). Many of these islets betray evidences of the landing of man thereon, in the occurrence of cosmopolitan insects. Perhaps the most unexpected record is the presence of the Diamond back moth (*Plutella maculipennis*) on most of the areas surveyed, including the remote Wake Island. The establishment of a cable station on Sand Island explains the presence of certain insects undoubtedly introduced from Honolulu. Of the two truly indigenous butterflies found in the larger Hawaiian Islands, *Lycæna bœtica* occurs only on Necker Island among the islets fringing the archipelago, while the migrant *Hypolimnas bolina* was only met with on Wake Island. Among the new species described in this bulletin, nine are parasitic Hymenoptera, sixteen are Coleoptera, and five are Lepidoptera.

A New Species of Paragonimus.—A. Gulati (*Mem. Dept. Agr. India*, Veterinary Series, vol. 3, No. 8, 1926) describes a new species of Paragonimus (*P. edwardsi*) from the lung of a palm civet (*Paradoxurus grayi*). Eight cysts were found in the lungs and in each were two flukes, the principal organs of which are described, but the accompanying illustrations are somewhat crude.

Studies on Sanguinicola.—Dr. L. Ejsmont describes (*Bull. Acad. Polon. Sci. et Lettres*, Ser. B. 1925, pp. 877-966 + 4 pls.) the structure and development of three species of the trematode Sanguinicola. The majority of the worms were obtained from the heart and bulbus arteriosus of tench and carp (*Cyprinus carpio* and *Carassius carassius*). The largest number of worms (which are usually 0·6 mm. to 1 mm. long) found in any one heart was thirty. The distinctive characters of the genus and of the three species are given in detail. *S. armata* occurs only in tench, *S. inermis* was found exclusively in *Cyprinus carpio*, and *S. intermedia* n. sp. in Carassius. The author has found sporocysts and two species of cercariæ of Sanguinicola in *Limnaea stagnalis* and *Bithynia leachi*, and suggests that the smaller cercaria from Limnæa belongs to *Sanguinicola intermedia*, and the larger one from Bithynia to *S. armata*. A table is given showing the characters of other blood-inhabiting trematodes.

Preservation of Wild Nature in Crimea.—The flora and fauna of the Crimea are of special interest since these include a large number of typically Mediterranean elements and a considerable percentage of truly endemic forms. With the view of preserving natural conditions in their virgin state, a national reservation was recently formed stretching over 23,000 hectares (*Priroda*, No. 2, 1927), and comprising uplands rising to 1500 metres, covered with forests of Crimean beech (*Fagus taurica*) and oaks (three species). Amongst other interesting plants are large juniper trees (*Juniperus foetidissima*), some of which are 500 years old; trees of *Taxus baccata*, which species is dying out in Crimea, and white birch, which occurs here only in single specimens, as a relict of a colder age. Mammals occurring in the preserved area include the local race of deer, an endemic species of marten (*Martes rosanovi*), and others, while birds are also represented by local species and races. Since 1925 a biological and a meteorological station have been organised; the latter is specially engaged in a study of the importance of mountain forests for condensation and preservation of moisture, this being a very important economic problem in the Crimea, where deforestation of mountains resulted, as in many other countries, in diminution of the mountain streams necessary for irrigation of lower-lying parts of the country. In 1926 a small local museum was established.

Poisonous Plants of South Africa.—The problem of stock-raising in a comparatively new country is often complicated by the rôle played by the poisonous plants of the region, and it takes many years of the trial and error method before the poisonous forms can be definitely separated from the harmless species. In this connexion the Botanical Survey of South Africa has performed a useful service to the agricultural community in publishing Memoir 9, "A Preliminary List of the Known Poisonous Plants Found in S. Africa." The knowledge incorporated in this work is mainly due to the researches carried out by the Division of Veterinary Education and Research, and while the information is yet incomplete, sufficient data have been collected to warrant a botanical description of such species as have been definitely proved poisonous. The fifty-one species of plants included have been shown by experimental feeding tests to be injurious to stock, or by chemical analyses to contain poisonous substances. A brief description of each plant is given, and a key to the genera facilitates identification of the various forms, which are illustrated by twenty coloured plates. In addition, notes on the symptoms and diseases produced are appended for each species.

Electric Currents and Plant Tissues.—Prof. H. H. Dixon and T. A. Bennet-Clark have investigated the responses of plant tissues to electric currents for the purpose of establishing some quantitative relation between stimulus and response, and their results shed some light on the mechanism of control of permeability (*Scientific Proceedings of Royal Dublin Society*, vol. 18 (N.S.), No. 29, Feb. 1927). By observing the response in the actual stimulated cells themselves, the uncertainties connected with the propagation of the stimulus, and the conversion of the propagated stimulus into response, are eliminated. The authors find that the passage of an electrical current through a tissue leads to a change in the electrical resistance and the permeability of the tissue. Pieces of *Hedera helix* cut 1 cm. square were used. A moderate stimulus (120 volts for 0·1 sec.) is immediately followed by a very rapid fall in resistance, the rate of which becomes less rapid. After a few slight undulations, recovery takes place in about an hour, and resistance becomes the same as before stimulation. It is found that response to a stimulus does not develop instantaneously, and maximum change in permeability is only attained 5 min.-10 min. after stimulation. This seems to indicate that the change cannot be entirely due to concentration of ions in the vicinity of the membrane, and it seems probable that the change in concentration of ions produced by stimulation initiates a secondary colloidal change, taking time to reach its maximum and affecting the structure of the semi-permeable membrane. It is supposed that the ability of a current to stimulate a cell is determined by the potential difference across the membrane of the cell.

Reversal of Magnetic Dip in Geological Time.—Perhaps the most interesting feature of the December issue of *Terrestrial Magnetism and Atmospheric Electricity* is a letter by P. L. Mercanton on a possible inversion of magnetic dip in the course of geological ages. Volcanic lavas in cooling are found to take up a feeble degree of magnetisation, which is very stable and is along the direction and proportional to the intensity of the magnetic field at the point; this occurs after the lava has ceased to be capable of much change of form, and therefore the direction of magnetisation as now observed indicates the direction of the earth's field at the time of setting of the lava, except for any later tilting of the whole lava layer. It is found that the magnetisation of lava specimens is unaffected by considerable artificial impacts. In view of these facts, it is of extreme interest that specimens of lava from Spitsbergen, Greenland, and Jan Mayen indicated almost without exception a magnetic dip of sign contrary to that now existing in Arctic regions. The lava was of tertiary epoch.

More recently, specimens have been obtained, through Sir Edgeworth David and others, of lava from Queensland and New South Wales; they also appear to show a reversal of magnetic dip in the southern hemisphere in permocarboniferous times. These results are so astonishing and of such great significance for any theory of the origin of the earth's magnetic field that it is to be hoped that they will impel other investigators to make similar measurements on specimens from other parts of the globe.

Coalfields of Wales.—The National Museum of Wales has published a pamphlet by Dr. F. J. North: "Coal and the Coalfields in Wales" (Cardiff: National Museum of Wales; London: Oxford University Press; 1*s.*) in order to make the Museum exhibits relating to the coalfields of Wales more readily intelligible. The work consists of a description of coal and its constitution, of the manner in which coal is produced, and of the general geological condition under which it was deposited. There is also a brief description of the animal and vegetable life of the Coal Measure period. The South Wales coalfield and the coalfields of North Wales are each described in some detail, the useful mineral products other than coal which are obtainable from the rocks of the Carboniferous period are briefly discussed, and the work terminates with a bibliography in which all the works referred to in the present publication are catalogued. The little work is written in a simple and straightforward style, and should answer quite satisfactorily its purpose of giving a clear idea of the origin and nature of coal to the general reader. It has been carefully done, and few errors have been noted.

Electron Scattering in Helium.—The March number of the *Physical Review* contains a full account of Dr. E. G. Dymond's work on the scattering of electrons by helium atoms. A preliminary account of these difficult experiments was given in Nature a short while ago (Sept. 4, 1926, p. 336). Differential pumping has to be utilised to maintain a very low pressure in the analysing chamber, and yet have the necessarily higher pressure of about 0·05 mm. in the attached collision chamber. In the latter, the magnetic field of the analysing coils has to be neutralised by means of an auxiliary solenoid, whilst the electron currents are so small that it is frequently necessary to use a Compton electrometer with a sensitivity of 25,000 mm. per volt in order to measure them. The principal loss of energy for the slower electrons is due to excitation of the 2^1S state (20·5 volts); for faster incident pencils there is an increasingly larger number of electrons which suffer retardation over a continuous range between 22 volts and several hundred volts. The angular distribution curve of electrons which have lost energy equivalent to 20·5 volts is a rosette pattern with a number of maxima, the main one being in the forward direction. As is pointed out by Dr. Dymond, the complete investigation will take a considerable time, because of the presence of three variables, the initial velocity of the electrons, their velocity after collision, and the angle of scattering. The field which has been opened up is, however, very wide, and future results may be expected to have an important bearing on the development of atomic theory.

The Propagation of Flame.—The observations of Mason and Wheeler on the propagation of flame in inflammable gas mixtures have raised the question as to whether the conduction of heat is one of the factors which determine flame speeds. A comparison of the speeds of flame in mixtures of different thermal conductivity should test the mechanism of flame propagation. For this reason H. F. Coward and G. W. Jones have determined the speed of uniform movement of flame in mixtures of methane with air, and with artificial atmospheres of oxygen with argon or helium. The results are reported in the *Journal of the American Chemical Society* (Feb. 1927), and they show that the transference of energy, whether by conduction or radiation, is so rapid that little change in the flame speed is observed. It is evident that the most important factors are the amount of heat developed, the heat capacities of the constituents, and the rate of reaction.

Fatigue of Metals in the Presence of Chemicals.—Reports and Memoranda No. 1054 of the Aeronautical Research Committee (London: H.M.S.O. 1*s.* net), by G. D. Lehmann, discusses "The Variation in the Fatigue Strength of Metals when tested in the Presence of Different Liquids." Some work has previously been done on similar lines by Haigh, J. A. Jones, G. Slater, S. C. Langdon, and others. The present experiments concern researches carried out in the engineering laboratories at Oxford on the suggestion of the Elasticity and Fatigue Sub-Committee of the Aeronautical Research Committee. The most unusual result found is the increase of the fatigue limit by 6 per cent. when the steel was tested in the presence of common salt. Wohler fatigue tests have been made on standard steels in the presence of hot aqueous solutions of sodium nitrate, in sodium or ammonium chloride, in water, after the steel had been pickled in sulphuric acid, and in oil. Control tests were made in hot water and in air at the atmospheric temperature. The results show that oil has no effect, while ammonium chloride reduced the fatigue strength 16 per cent., and sodium chloride *raised* it by 6 per cent. Sodium nitrate produced no effect on a steel with 0·33 per cent. carbon, but lowered the fatigue limit of 0·13 per cent. carbon steel by 4 per cent. Pickling reduced the fatigue strength by about 8 per cent.

Activity Coefficients of Electrolytes.—The *Journal of the American Chemical Society* (Feb. 1927) contains two interesting papers on the activity coefficients of electrolytes determined by the solubility method. The first paper, by V. K. La Mer, C. V. King, and C. F. Mason, describes measurements made to test the validity of the Debye-Hückel limiting law when applied to salts of high symmetric valence type. Luteo-cobaltammine ferricyanide is a very suitable salt for this purpose, and its solubility was determined in solutions of potassium nitrate, magnesium sulphate, and sodium chloride. The results obtained for the first two solutions are in excellent agreement with the law, but with sodium chloride there are noticeable discrepancies. Nevertheless, the data are interpreted as substantiating the limiting law, at least in its broader aspects. The second paper, by La Mer and Mason, concerns the activity coefficients of salts of high unsymmetric valence type, in this case two cobaltammine salts with the luteo ion as cation. The limiting law was confirmed for a number of solvent salts containing univalent anions, but with solvent salts having anions of higher valency, marked discrepancies were noticed. It is believed that these deviations are due to the fact that the higher terms in the Debye-Hückel expression for the density of electricity have been neglected, factors which become most pronounced for solutions of this type. Qualitative agreement is obtained when these terms are taken into account, and further experiments are in progress to test the truth of the modified principles when applied to examples in which the present form of theory fails.

James Hutton: Father of Modern Geology, 1726–1797.[1]

JAMES HUTTON has been justly claimed by Sir Archibald Geikie as the 'father of modern geology.' He was born and bred in Edinburgh, where his father had held the post of City Treasurer. From the High School he went to the University. A chance reference to the potency of *aqua regia*, introduced by way of illustration in a lecture on logic, turned his young fancy to thoughts of chemistry. He followed up the subject in a lexicon; and, when presently apprenticed to a lawyer, he spent his time in making chemical experiments rather than in copying papers. "With much good sense and kindness," Playfair naively remarks, his employer "released him from his obligations." Medicine now seemed the only refuge. Hutton studied in Edinburgh, Paris, and Leyden, where he graduated; but he never practised. His chemical experiments, wonderful to relate, found commercial application; and, with an income in prospect, he turned to agriculture. For experience he went to Norfolk, and it was in England that he first developed an interest in geology.

It is impossible to follow Hutton in detail as Berwickshire farmer and Edinburgh man of science. He travelled considerably, he experimented, he read, and he conversed. He inspired enthusiasm in his circle; and it is mainly through his friends, and after his death, that he exercised an influence upon the course of geology. Playfair's "Illustrations of the Huttonian Theory of the Earth" appeared in 1802 and supplied the foundations upon which Lyell in 1830 reared his "Principles of Geology." Hutton himself was one of those great men who write badly. His "Theory of the Earth," whether we turn to it in the first volume of the *Transactions of the Edinburgh Royal Society*, or in its later expanded book form, is almost unreadable.

Hutton made his mistakes, and in his more important discoveries he was sometimes in part anticipated. This much must be taken almost for granted in presenting a brief account of his achievements. There is, however, one failing that must be mentioned for fear that readers, discovering it for themselves, may be unduly alarmed. Hutton continually explains geological phenomena on the basis of design—"the purpose of this earth," he assures us, "is evidently to maintain vegetable and animal life." Most readers will consider this mode of expression unscientific; but they must always remember that Hutton has righted himself, not only in practice, but also in words. "In the use of means," he explains, "we are not to prescribe to Nature those alone which we think suitable for the purpose, in our narrow view. It is our business to learn of Nature (that is by observation) the ways and means which in her wisdom are adopted."

Hutton's comprehensive contribution to geology is that the past should be, so far as possible, interpreted in the light of the present. His individual discoveries may be enumerated under five headings as follows:

(1) Igneous Rocks.—Hutton recognised basalt, porphyry, and granite as igneous rocks. The ideas which led him to look for igneous rocks are open to criticism; but the criteria of character and behaviour which he adopted for distinguishing these rocks from sediments have proved trustworthy in most of their applications. Verification of scientific prophecy is always pleasant. Hutton foretold the intrusive relations of granite from inspection of its unstratified crystalline appearance. He confirmed his expectations by visiting Glen Tilt and Arran.

Without going into detail we may recall that Hutton would not admit that any of the Scottish igneous rocks had reached the surface; all were, for him, "subterraneous lavas." The credit of recognising ancient surface lavas belongs to Hutton's contemporaries, Arduino and Desmarest, working in recently extinct volcanic tracts of southern Europe.

(2) Elevation.—Hutton claimed that the ancient consolidated sediments now so widely exposed to view have been elevated. Most other geologists had withdrawn the sea, instead of elevating the sediments. Hutton, however, emphasised the folded and fractured nature of the upheaved sediments. He also looked for, and found, *unconformities*, which proved to his satisfaction that cycles of elevation and erosion are followed by cycles of depression and sedimentation.

(3) Erosion.—Hutton's conception of the connexion of landscape with commonplace erosion is strikingly modern in its more essential features. It is true that in this great matter he was anticipated by Desmarest—so far as publication is concerned; but there can be no question of the originality of his views, and of the influence they had upon the development of science. "From the top of the decaying pyramids to the sea," he says, in summarising his arguments, "throughout the whole of this long course, we may see some part of the mountain moving some part of the way. What more can we wish? Nothing but time."

(4) Geological Time.—Hutton realised to the full the immensity of geological time. He had satisfied himself that the various processes of erosion are observable realities, and that they stand in causal relationship to the details of landscape. He was undeterred by the fact that Roman roads can still be traced across the hills of Britain, and that one of their sea-baths out into the rocks of the Mediterranean shore remains unspoilt. His deduction is confident. The antiquity of history is but the yesterday of geology. In geology itself he saw "no vestige of a beginning—no prospect of an end."

(5) Glaciers.—Although Hutton was often puzzled by the transport of boulders in his native land, he did not conjure up Scottish glaciers to do the work. On the other hand, he did propose a former vast extension of existent Swiss glaciers to account for the distribution of Mont Blanc boulders which de Saussure had ascribed to deluges. "Let us now consider," he says, "the height of the Alps, in general, to have been much greater than it is at present; and this is a supposition of which we have no reason to suspect the fallacy, for the wasted summits of those mountains attest its truth. There would then have been immense valleys of ice sliding down in all directions towards the lower country, and carrying large blocks of granite to a great distance, where they would be variously deposited, and many of them remain an object of admiration to after ages, conjecturing from whence or how they came."

After perusing Hutton's "Theory of the Earth," the reader may well inquire whether there is any fundamental geological conception to which the author has not contributed. There is one. Hutton used fossils as an indication of ancient conditions of deposit and as evidence of upheaval. He did not recognise the succession of life which they record. Scottish fossils are not as a rule so unlike modern forms as are the ammonites of England. It was natural for Newton's contemporary Hooke (1635–1703) to surmise on the extinction of ancient organisms; and for Hutton's contemporary, William Smith (1769–1839), to establish that "strata" can be "identified by their organised fossils." No Scottish geologist need grudge these laurels to the Southerner.

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[1] From the bicentenary address, delivered on Feb. 16 by E. B. Bailey, to the Edinburgh Geological Society.

The Morphology of Filterable Viruses.

Three brief papers in the December number of the *Journal of the Royal Microscopical Society* by J. E. Barnard, J. Smiles, and F. V. Welch, discuss the great difficulties of determining the outward forms of the filterable viruses, and some contribution is made towards improved methods of attack. Mr. Barnard states that all ordinary bacteria may be stained and their size and form demonstrated if they are not less than 0·2 μ in diameter. The virus of bovine pleuro-pneumonia, which can be definitely and readily grown in artificial media, comes within this limit, but its minute size has precluded any satisfactory knowledge of its real appearance and of any possible phases through which it may pass in its growth cycle. Staining processes, moreover, have not helped matters.

Mr. Smiles has, by the aid of a dark-ground illuminator and an unstopped oil-immersion objective of 2 mm. focal length and 1·20 N.A., attempted to follow the changes in shape which occur in the virus bodies growing in fluid medium. Drawings of the observed changes are given, and it would appear that, in young culture, grouping of the organism is the chief feature. These groups consist of spherical, aspherical, and granular forms with occasional elliptical and cylindrical masses. These may be so closely apposed to each other as to render difficult the definition of connecting links. Short connecting filaments of low visibility have, however, been detected. As the culture ages, the number of organisms per group diminishes, and finally the culture shows merely single spheres, some with attached granules and some without, and also free granules. Mr. Smiles suggests that in growth the initial spherical form elongates to form the cylindrical type, and this latter breaks up again into two or three small spherical or granular forms. After 48 hours' incubation the cylindrical form may again break up into a chain of four or five granules which finally assume spherical form.

In the course of his work Mr. Smiles has also made use of pleuro-pneumonia cultures grown on thin films of media on ordinary microscopic slips as described by Mr. F. V. Welch. The method employed by him is eminently suitable for the object in view. It should not, however, be described as a new method, but only as one of many modifications of an old and extremely useful method for studying cultural growth *in situ* both in the fresh and in the fixed and stained condition.

University and Educational Intelligence.

The annual conference of the Association of Teachers in Technical Institutions will be held this year at Plymouth on Friday, June 3–Tuesday, June 7. The provisional programme includes, in addition to the business of the Conference, a number of excursions. Arrangements are being made to visit, amongst other places, the Seale Hayne Agricultural College and the Marine Biological Laboratory, Plymouth. An important feature will be an educational and industrial exhibition in the Guildhall on June 4–10.

Applications are invited for the Astley Cooper Studentship at Guy's Hospital, value £150 per annum, plus an additional sum of £50 for expenses. The studentship is tenable for three years. By the terms of the will of the founder, the studentship may not be awarded to any member of the staff of Guy's or St. Thomas's Hospitals, or to any one related by blood or affinity to them. Particulars may be obtained from Mr. C. H. Fagge, Guy's Hospital, S.E.1. The latest date for the receipt of applications for the studentship is May 31.

The Charles Lathrop Pack Forestry Trust, founded by Mr. Charles Lathrop Pack, president of the American Tree Association, has given 130,000 dollars for the endowment of a research professorship in forest soils in Cornell University. Generous provision has also been made for the expenses of the advanced investigations to be undertaken, which will be done in the New York State College of Agriculture. The proposed work is a new development in forest research in the United States. Mr. Pack has made other large gifts for the promotion and support of education in forestry. Recently announcement was made concerning the Charles Lathrop Pack Demonstration Forest, 2500 acres of white-pine land on the main Adirondack highway near Lake George; and he has given land or endowments to other American forestry schools, including the New York State College of Forestry, the Yale Forest School, and the University of Washington.

The fifth Pan-American Child Congress is to be held at Havana in Cuba with the official support of the Government. Owing to difficulties arising from the hurricane the date has been postponed until December 1927. An international exhibition on child hygiene will be held in connexion with the meeting. The Congress will be divided into six sections, dealing with medicine, hygiene, sociology, education, psychology and legislation, and the languages admitted will be Spanish, English, Portuguese, and French. There will be two governmental sessions, for official delegates only; at these, resolutions prepared by the committees will be put to the vote. A draft programme has been prepared with twelve leading topics for each section. As compared with other educational conferences it is interesting to note the great stress on the medical aspects of our problems. The Secretary-General is Dr. Felix Hurtado, Circulo Medico (Malecon 15), Habana. Some information in English typescript has also been circulated by the Commissioner of Education, United States Department of the Interior, Bureau of Education, Washington.

After an experimental period of five years, a record of which is given in the Report of the Central Scholarships Committee of the Ministry of Agriculture and Fisheries (London: H.M.S.O.), the Government has decided to continue the awards of scholarships for the sons and daughters of agricultural workers under a slightly modified scheme. Junior scholarships are provided for short courses in agriculture, horticulture, dairying or poultry-keeping at farm institutes, while senior scholarships are intended for diploma or degree courses in agricultural, veterinary, or allied sciences at universities or appropriate colleges. The senior grade is normally reached after passing through the junior grade, but certain exceptions may be made. All scholarships will allow of attendance at the courses free of cost to the parents. Candidates must be either *bona fide* workers in agriculture or sons or daughters of agricultural or rural workmen, or of working bailiffs and smallholders whose means are comparable with those of agricultural workmen. Provided that a sufficient number of suitable applications are received, about one hundred and twenty junior, ten extended junior, and ten senior scholarships will be awarded this year. Forms of application, to be returned before April 30, and full particulars may be obtained from the Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, London, S.W.1, or locally from the offices of County Councils.

Calendar of Discovery and Invention.

April 17, 1823.—Though Dalton in 1801 had remarked, "There can scarcely be a doubt entertained respecting the reducibility of all elastic fluids of whatever kind into liquids, and we ought not to despair of effecting it in low temperatures and by strong pressures exerted on the unmixed gases," it was not until 1823 that the question was submitted to systematic experiment. Faraday then first obtained liquid chloride and afterwards liquid carbonic acid, ammonia, etc. The details of this work were given to the Royal Society by Faraday in two papers dated Mar. 13 and April 10, and on April 17, Davy in another paper suggested the employment of some of these substances as mechanical agents.

April 17, 1891.—Mechanical traction on common roads long met with opposition from the authorities, and it was an important gain when on April 17, 1891, Leon Serpollet received authorisation to place his steam cars on the streets of Paris.

April 19, 1758.—On this day John Dollond obtained a patent for his achromatic telescope, and that same year he received the Copley Medal "for his curious experiments and discoveries concerning the different refrangibility of the rays of light," communicated to the Royal Society.

April 21, 1686.—As is well known, the publication of Newton's "Principia" was mainly due to Halley. On April 21, 1686, Halley read "A Discourse concerning Gravity" to the Royal Society as preparation for the "incomparable treatise of motion almost ready for the press"; six days later, Dr Vincent presented to the Society the manuscript of the first book of the "Principia," and on May 19 the Society resolved that "Mr. Newton's Philosophiæ Naturalis Principia Mathematica be printed forthwith in quarto, in a fair letter."

April 21, 1783.—One of the great scientific controversies of the eighteenth century concerned the discovery of the composition of water. The experiments of Cavendish were described in a paper in January 1784, but Watt, so early as April 21, 1783, had written to Black, "In the deflagration of inflammable and dephlogisticated airs, the airs unite with violence—become red hot,—and on cooling totally disappear. The only fixed matter which remains is water, and water, light, and heat are all the products. Are we not then authorised to conclude that water is composed of dephlogisticated and inflammable air?"

April 22, 1663.—The first Charter of Incorporation of the Royal Society was granted in 1661 but it having been found that this failed to give the Society certain privileges essential to its welfare, a second charter was obtained, the patent for which was dated April 22, 1663.

April 23, 1868.—In a paper read to the Royal Society on April 23, 1868, Huggins described the first successful investigation of the motion of the stars in the line of sight by the application of Doppler's principle, announced in 1842.

April 23, 1884.—It is estimated that the development of the steam turbine has halved the cost of the generation of electricity. Though there had been many earlier inventions, no advance was made until 1884, when de Laval and Sir Charles Parsons secured their patents. The patents of Parsons, Nos. 6734 and 6735, taken out on April 23, 1884, were for "improvements in electric generators and in working them by fluid pressure" and for "improvements in rotary motors actuated by elastic fluid pressure, and applicable also as pumps."

E. C. S.

Societies and Academies.

London.

Institute of Metals (Annual General Meeting), Mar. 9.—**D. Hanson** and **Grace W. Ford**: Investigation of the effects of impurities on copper. Pt. V.—The effect of bismuth on copper. Experiments on copper containing up to 0·1 per cent. of bismuth confirm the great embrittling effect of bismuth, and indicate that when more than a trace of bismuth alone is present in copper, the working properties, particularly the cold-working properties, are seriously affected. The solid solubility of bismuth in copper has also been investigated.—**Clement Blazey**: Brittleness in arsenical copper. A description is given of a type of brittleness in arsenical copper tubing developed by annealing in the temperature range 450° to about 650° C. The susceptibility to brittleness was inherent in the 'as cast' billets from which the tubes were made, and no alteration in hot and cold working methods could eliminate it. The degree of susceptibility varied from billet to billet, but the variation could not be connected with chemical composition. After remelting, no trace of brittleness could be developed. Over a period of several years the brittleness was encountered in a certain mill on three occasions, and appeared to be connected with the composition of the refinery charges and with melting operations.

Mar. 10.—**R. Genders**: The penetration of mild steel by brazing solder and other metals. The cracking of mild steel under slight stress when heated and wetted with brazing solder is due to rapid intercrystalline penetration of the steel by the brass. Copper behaves similarly to brass, but zinc, tin, and lead-tin solder have no perceptible action. The phenomenon of intercrystalline penetration is in many cases of a complex character, involving a third factor.—**H. J. Miller**: The penetration of brass by tin and solder, with a few notes on the copper-tin equilibrium diagram. The cracking of stressed brass articles by a process of intercrystalline penetration when in contact with molten solder of the tin-lead variety is associated with the phenomenon of 'season-cracking' and the penetration of mercury into brass. Tensile tests upon brass test-pieces surrounded by various molten metals and solders indicate that the stress required for penetration to take place is much higher than that required for the penetration of mercury. The eutectic composition of the series copper-tin alloys occurs with about 0·7 per cent. of copper as against 1 per cent. by Heycock and Neville, 2 per cent. by Guertler, Shepherd, and Blough, and 5 per cent. by Giolitti and Tavanti.—**Harold J. Hartley**: The attack of molten metals on certain non-ferrous metals and alloys. Penetration of the molten into the solid material occurs when the latter is stressed in tension. Fully annealed materials are attacked at very low stresses with ultimate breakdown.—**H. Moore** and **S. Beckinsale**: Notes on the manufacture and properties of hairsprings. To raise the elastic limit to the required degree, hardening by heat-treatment or by cold-working is necessary, but all hardening operations are liable to produce a state of imperfect elasticity detrimental to the spring. The use of low-temperature heat-treatments to restore elasticity after cold-working (drawing, rolling, and the coiling of the spring) is described. Steel hairsprings are subject to corrosion, but elinvar is highly resistant.—**F. Hargreaves**: (1) The application of strain methods to the investigation of the structure of eutectic alloys. Investigation of the lead-tin, tin-zinc, and copper-silver eutectics shows that straining by suitable methods results in markings due to slip, similar to those which occur in the case of pure metals. The orientation of the lead-tin eutectic is apparently determined by that of the tin. (2) Note on the crystallisation of the lead-tin eutectic. Straining and etching methods applied to a 30-lb. ingot of lead-tin eutectic show the exterior to possess the largest crystal size with absence of distinct colonies. The middle consists of much smaller crystal units in the form of distinct colonies of coarser eutectic structure.—**J. D. Grogan**: The influence of calcium on aluminium containing silicon. With an appendix on the estimation of calcium in aluminium alloys by **P. G. Ward**. Calcium combines with the silicon present in commercial aluminium, forming a compound, probably $CaSi_2$, which is almost insoluble in solid aluminium at all temperatures and exerts no age-hardening influence. By removing silicon from solid solution in aluminium, calcium improves the electrical conductivity of the latter.—**M. Hansen**: Note on the magnesium-rich magnesium-copper alloys. Some indication of the phase boundary of the solid solution of magnesium with copper has been obtained. The quenched alloys show no perceptible hardening by ageing.—**R. Genders**: The mechanism of inverse segregation in alloys. With an appendix on the accurate determination of copper in bronze by electrolysis by **R. A. F. Hammond**. None of the hypotheses which has been put forward to account for the occurrence of inverse segregation in alloys is fully in accordance with experimental fact. Some further factor must be taken into consideration. In extreme cases of inverse segregation, exudation at the surface of the casting occurs simultaneously with the escape of evolved gases. The variation of composition in chill-cast slabs of bronze containing 5 per cent. tin made by various methods of casting were determined. Considering the flow taking place in the mould during the formation of the ingot in relation to these results, a general theory of inverse segregation is advanced, in which the gas constituent in alloys is considered as part of the system. The evolution of gas from solution in the metal is regarded as of primary importance in determining variations in composition in the solid casting.—**K. Honda** and **H. Endo**: Magnetic analysis as a means of studying the structure of non-magnetic alloys. The present investigation is to show by means of examples that magnetic analysis applied to the case of non-magnetic elements, which are paramagnetic or diamagnetic, affords a convenient method of studying the equilibrium diagram for the alloys consisting of these elements. Not only is the melting point or the transformation point of an element given by a sharp discontinuity of the susceptibility-temperature curve, but the liquidus and the solidus of an alloy are also marked by a sharp break or bend. In some cases, small solubility is marked by a very large abrupt diminution of the diamagnetic susceptibility of one component on adding a small quantity of the other. Magnetic analysis is also convenient for the study of the actual state of an alloy when above its melting point, that is, in detecting the existence of an intermetallic compound in the liquid phase, the degree of dissociation of the compound with the rise of temperature, etc.—**J. Newton Friend** and **W. E. Thorneycroft**: Note on the silver contents of Roman lead from Folkestone and Richboro' Castle. Specimens of Roman lead from Folkestone and Richboro' Castle contained 0·0072 and 0·0078 per cent. respectively of silver.

Geological Society, Mar. 9.—**L. J. Chubb** and **W. Campbell Smith**: The geology of Maiao (Society Islands). Maiao, or Tubai Manu, which lies some 50 miles west of Tahiti, consists of a small volcanic island about a mile long and 800 feet high, encircled by a barrier-reef six miles in diameter. The volcanic rocks collected from the central island include a basalt with numerous phenocrysts of olivine and augite, of the type known to be abundant in Tahiti and the Austral Islands, a phonolitoid nepheline-tephrite, and an olivine-bearing basaltoid nepheline-tephrite somewhat similar to those described from Rurutu.—**C. I. Gardiner**: The Silurian inlier of Woolhope; with palæontological notes by **F. R. C. Reed**. The beds seen in the inlier are those between the Llandovery and the Downtonian. The uppermost beds frequently show a slightly eroded surface, and on this rests a conglomerate of clay-pebbles or limestone fragments full of fish remains, forming the base of the Downtonian. Higher up come false-bedded sandstones and shales, and the highest beds seen are sandstones yielding *Lingula cornea*. The inlier has been affected by pressures in two directions. One from the south-west has markedly affected the southern portion of the inlier, at places bringing Downtonian deposits into contact with the Wenlock Limestone. The main result was the bending of the Silurian rocks into an anticline. Pressure also produced an anticline, the axis of which runs north-north-east and south-south-west. The two pressures have produced a more or less dome-like arrangement of the beds, but much faulting has gone on in parts of the area near Sollers Hope, Old Sufton, and Woolhope Cockshoot. Dr. F. R. C. Reed describes fourteen new species and five new varieties of brachiopods, lamellibranchs, gasteropods, and trilobites.

Optical Society, Mar. 10.—**Basil Graves**: Microscopy of the living eye. The uses and advantages are illustrated of using a narrow beam of light for illumination and arranging that the axis of observation is so positioned as to place the object under view in the most favourable condition for observation, against a bright or dark background as the case may be. The non-coincidence of the observing and illuminating axes also enables troublesome specular reflections from the corneal and lens surfaces to be eliminated. Illumination by means of the reflection of the narrow beam from the iris, termed by the author 'retro-illumination,' is described. The rendering visible of the track of the light beam through the ocular media is explained and a term 'relucency' suggested for this property. As the result of continued observation over a period of years, the probable duration of certain conditions, in the crystalline lens for example, is capable of estimation.

Physical Society, Mar. 11.—**G. M. B. Dobson** and **I. O. Griffith**: Measurements of absorption coefficients of light filters. A portion of the slit of a spectograph is covered by the absorbing medium, and in front of the photographic plate or of the slit a neutral wedge is placed. The resulting spectogram consists of two parts, one due to light which has passed through the filter and the wedge, the other to light which has traversed the wedge only. From a knowledge of the distance between two points, one in each part of the spectogram, which are of the same density, the absorption coefficient of the filter at any wave-length may be determined. The source of light need not be constant.—**T. L. Ibbs** and **L. Underwood**: A comparison of the behaviour in thermal diffusion of nitrogen and carbon monoxide, and of nitrous oxide and carbon dioxide. The gas analysis required in the measurement of the effect is made by means of the Shakespear katharometer. The behaviour of nitrogen is similar to that of carbon monoxide. The effect given by carbon dioxide is generally a little greater than that given by nitrous oxide. The pairs of gases examined provide a special case for the application of the Enskog-Chapman theory, as in each pair the molecular weights and mean collision areas are the same. It can thus be deduced that the molecular field of nitrogen is similar to that of carbon monoxide, and that the field of carbon dioxide differs little from that of nitrous oxide.—Robert R. **Nimmo**: Relighting of a neon lamp when momentarily extinguished at voltages below the striking potential. The time for which the continuous discharge of a neon lamp may be interpreted without putting out the lamp is of the order of 50 micro-seconds and depends on the voltage across the lamp and on the current passing through it —G. B. **Deodhar**: Electricity of dust clouds The factors governing the phenomena of electricity of dust storms are: (1) Material of the dust; (2) its size; (3) the gas raising the cloud, (4) the velocity of the gas; (5) the temperature. The first two factors are discussed. The electricity developed is of frictional nature Some quantitative estimates of electrification of chlorides and nitrates of sodium and potassium are made, showing that chlorides of sodium and potassium are equally efficacious, whilst sodium nitrate is about 4½ times as efficacious as potassium nitrate. Using prepared and graded dusts, it is shown graphically that, other things being the same, the number of volts developed by blowing increases very rapidly as the size grows less.

Mineralogical Society, Mar. 15.—C. E. **Tilley**: A melilite - spurrite - Ca_2SiO_4 assemblage from Larne (Antrim) This contact metamorphic assemblage, together with merwinite, perovskite, wollastonite, ægirine, and other minerals, occurs at the borders of Cretaceous limestone and a Tertiary dolerite near Larne. The rocks give evidence of considerable chemical interchange during metamorphism.—G. T. **Prior**: Alkaline rocks from Nimrud volcano, Armenia. Nimrud was a centre of eruption of alkali rocks similar to those of the Rift Valley, East Africa. The lava forming the main mass of the rim and the floor of the crater is a soda-rhyolite (comendite) containing anorthoclase felspar and the soda-pyroxenes and soda-amphiboles ægirine, cossyrite, and riebeckite. More basic lavas overlying the soda-rhyolites resemble the kenytes of East Africa in containing numerous corroded phenocrysts of anorthoclase. Ordinary olivine-basalts with phenocrysts of labradorite also occur.—G. **Greenwood**. Rotating crystal X-ray photographs. The first part of the paper deals with this method of crystal analysis as used in the German laboratories, where it was studied by the author. Two substances, tetramethylammonium iodide $N(CH_3)_4I$ and tetraethylammonium iodide $N(C_2H_5)_4I$ were investigated. The unit cell of $N(CH_3)_4I$ is a tetragonal unit of dimensions $a = 8\ 05$ Å.U and $c = 5{\cdot}75$ Å.U., and the space group is either D_4^1 or V_d^3, most probably the latter. Hence the crystal class is not the holohedral one proposed by L. Vegard. The unit cell of $N(C_2H_5)_4I$ has dimensions $a = 12{\cdot}29$ Å.U., $c = 6{\cdot}82$ Å.U. when referred to the axes demanded by the scalenohedral space group V_d^8 to which the substance belongs. A smaller unit can be found, using as a axis half the base-diagonal; the cell then has $a = 8\ 86$ Å.U. and $c = 6\ 82$ Å.U. The nitrogen and the iodine atoms in both substances are crystallographically identical, but the methyl and ethyl radicles may be half of one kind and half of another. The hypothetical structures suggested for these substances by Groth, as deduced from topic axes, are also discussed.—L. J. **Spencer**: Biographical notices of mineralogists recently deceased (third series). The average age of the forty lives described was sixty-eight years.

Royal Meteorological Society, Mar. 16.—G. I. **Taylor**: Turbulence (Symons Memorial Lecture). Turbulence is a condition of motion in a stream of fluid which occurs when it flows past solid surfaces or when two layers of fluid flow over one another. Turbulence increases the diffusing power of air until it is 100,000 times as great as that of air at rest. So great is this effect that in the case of tidal motions in the sea it is possible to prove that turbulence is responsible for the gradual slowing down of the earth's rotation, and consequent lengthening of the day which astronomers have been able to observe. Some observations of the details of turbulence show that eddying motion in the atmosphere is spread out equally in all directions in space.

Dublin.

Royal Dublin Society, Feb. 22.—E J. **Sheehy**: The correlation of nutritive value with dry matter content of pastures. Two pastures, in which the nutritive value or stock-carrying capacity was in the ratio of about 3 to 1, were compared. The chemical analysis of the dry matter of the herbage—total nitrogen, ether extract, crude fibre, nitrogen-free extract, and total ash—showed no material difference, nor did the digestibility of the herbage from the two pastures differ. A difference in dry-matter content, which amounted to about 25 per cent. in favour of the richer pasture, was revealed; and a correlation was established between the dry-matter content and the proportions of grasses, clovers, and broad-leaved miscellaneous plants (weeds) present.—J. **Wilson**: The maintenance requirements of cattle on different kinds of rations and at different rates of production. Contrary to Kellner's and Armsby's assumption, it has been shown that maintenance not only rises with the rate of production, but that the rise is accelerated as the rate of production rises. The present paper discusses 'dynamic action' and suggests that such action is really a part of the digestive process, and the heat set free a result of the work done.

Paris.

Academy of Sciences, Mar. 7.—The president announced the death of Charles Graebe, *correspondant* for the Section of Chemistry —**Mesnager**: The rectangular beam loaded at a point Angle under the charge when it becomes infinitely long. Consequences for plates.—André **Blondel**. Methods for position-finding by Hertzian waves.—E **Mathias**: Contribution to the study of fulminating material (lightning): examples of spontaneous decomposition —M **Potron**: The distribution of a system of integers in groups of given sums.—Beniamino **Segre**. The diagrams of probability —Paul **Alexandroff**: A new generalisation of the Phragmén-Brouwer theorem.—**Jacques**· Networks the tangents of which belong to linear complexes.—G. **Pólya**. A theorem of Hadamard relating to the multiplication of singularities —**Hadamard**: Remarks on the preceding communication. — P. **Tzitzéica**: A certain system of partial differential equations.—D. **Riabouchinsky**: Some cases of cavitation. — Raoul **Ferrier**: Planck's oscillator.—Nicolas **Kryloff**: The approximate integration of some partial differential equations of mathematical physics.—Léon **Brillouin**· The statistics of light quanta (photons).—H. **Pélabon**: Rectifying contacts —S. **Piña de Rubies**: The arc spectrum of gadolinium. Measurements made at the normal pressure, between λ3100 and λ2200.—H. **Jedrzejowski**: The ionising powers of RaB and RaC —F. **Bourion** and E. **Rouyer**. The determination, by the boiling-point method, of the affinity relative to the formation of complex compounds between cadmium halides and the alkaline halides.—**H. Devaux** and **E. Aubel**: The absorption of ions by glass. The surface of glass (glass wool) is capable of absorbing the ions Ca, H, K, Na, NH_4, quinine, and the action is reversible. Glass behaves as a gel, since adsorption takes place not only at its surface but also in its mass.—**J. E. Verschaffelt**: The specific heats of a sufficiently cooled condensed phase. An adverse criticism of a recent communication under the same title by M. Perrakins.—**Henri Marcelet**: The heats of combustion of some oils of marine animals. Data are given for eight samples of oil, ranging from 8700 cal. to 10,790 cal. per gram.—**A. Travers** and **Jouot**: The iodometric estimation of the antimonic ion. The reaction between antimonic salts and potassium iodide is complete in the presence of a considerable proportion of concentrated hydrochloric acid.—**Ch. Courtot** and **O. Vignati**: Researches in the fluorene series.—**André Meyer**: The sulphonation of anthraquinone in the presence of mercury.—**Ch. Maurain**: The distribution of earthquakes in latitude. A statistical study shows that the frequency of earthquakes is greater the smaller the latitude.—**D. Faucher** and **E. Rougetot**: Contribution to the study of the mistral.—**P. Martens**: The vital structure of the nucleus and the action of fixing reagents.—**A. Guilliermond**: Cytological and taxinomic observations on yeasts of the group of the Sporobolomyces.—**J. Szymanek**: Some observations on the morphology of the mycelium and suckers of *Phytophthora infestans* in the tubercle of the potato.—**Bogdan Varitchak**: The development of the perithecium in *Cordyceps militaris*.—**P. Cappe de Baillon**: The descendance of double monsters of phasmids.—**Maurice Fontaine**: The comparative compressibility of the serum and the blood globules of the horse. The blood serum of the horse is less compressible than an isotonic solution of common salt. The complete blood is less compressible than the serum of the same blood.—**Roger Douris** and **Georges Giquel**: A method of differentiation of pathological sera (cancer, syphilis, tuberculosis). The characters of cancer serum. The turbidity produced by the addition of varying quantities of distilled water to the serum is compared with the same serum diluted with 0·9 per cent. sodium chloride solution. The difference in the optical density of the two tubes is determined in the Yvon photometer. The differences observed with normal sera are given by numbers between 0 and 3, for syphilitic sera, numbers between 3 and 10. If the number is higher than 10, under the experimental conditions described, the diagnosis is in favour of cancer.—**Y. Manouelian** and **J. Viala**: *Encephalitozoon Negrii*, the parasite of encephalomyelitis in young dogs.—**A. Borrel**: The verminous etiology of certain cancers.

GENEVA

Physical and Natural History Society, Mar. 3.—**F. Chodat**: The importance of isoelectric points in the preparation and activity of ferments. The author has studied the mother-liquors of the following ferments: saccharogenase, prunase, catalase, tyrosinase. In most cases several minima of dispersion occur in hydro-alcoholic media which are considered as indices of isoelectric points, each minimum corresponding to one of the amphoteric electrolytic colloids which are dispersed in the extract.—**S. C. Guha**: The preferential electric conductivity of the pistil of some plants. The pistil of the plants studied shows a basipetal preferential conductivity for the incident current, a difference which disappears after pollination.—**E. Briner** and **A. Schidlof**: The ebullioscopic paradox. It is established by calculation that external work is effected by the atmospheric pressure during the condensation of the vapour, and that this work is much higher than the compensating work, evaluated on the basis of a reversible transformation.—**E. Cherbuliez** and **P. Rosenberg**: Researches on the silicates. Having applied the determination of electrical conductivity to kaolin, quartz, and orthose, and to their mixtures, the authors have proved that kaolin presents very large variations as a function of the time to reach a limiting value, and this for several values of the temperature. The phenomenon is irreversible and follows the law of a monomolecular reaction.—**P. Balavoine**: The refractometric estimation of alcohol in fermentation products. The refractive indices of wine distillates have been examined, and it is shown that the volatile acidity of these distillates (mainly due to acetic acid) modifies these indices in a manner not permitting the use of an empirical correction table. A table has been prepared, based on the experimental data, which agrees well with the pycnometric measurements.—**R. Wavre**: The stratification of the planets and Fredholm's equation. Fredholm's equation, to which the problem of the stratification of the planets may be reduced, possesses a symmetrisable nucleus.

VIENNA.

Academy of Sciences, Feb. 17.—**A. Kieslinger**: Second preliminary report on geological petrographic researches in the Southern Kor Alps of Styria. A survey of the Kor Alps district including Unterdrauburg and Deutschlandsberg-Wolfsberg. The present reports concern metamorphic rocks and a series of mineralogical peculiarities—destratification (*Entschieferung*), deformations (*Verwachsungen*), recrystallisation (*Umkrystallisieren*), rough injected mica schist (*Glimmerschiefer*). Between the textures of the injection-changed rocks emerge remains of still older textures (*Durchbewegungstexturen*). The lamelliform gneisses with streaky texture are clearly intrusive rocks.

Official Publications Received.

British.

Biological Reviews and Biological Proceedings of the Cambridge Philosophical Society. Edited by H. Munro Fox. Vol. 2, No. 2, March. Pp. 91-197. (Cambridge.) 12s. 6d. net.

Aeronautical Research Committee: Reports and Memoranda. No. 1064 (M. 48): The Variation in the Fatigue Strength of Metals when tested in the Presence of Different Liquids. By G. D. Lehmann. Work performed for the Engineering Research Board of the Department of Scientific and Industrial Research. (E.F. 184.) Pp. 18+14 plates. 1s. net. No. 1066 (Ae. 229): Algebraic Formulæ for the Performance of an Aircraft at Full Throttle. By R. S. Capon. (D.1. Special Technical Questions, 151.—T. 2296.) Pp. 18. 9d. net. (London: H.M. Stationery Office.)

Colony and Protectorate of Kenya. Agricultural Census. Seventh Annual Report, 1926. Pp. 34. (Nairobi: Department of Agriculture.)

The British Mycological Society. Transactions. Edited by Carleton Rea and J. Ramsbottom. Vol. 12, Part 1, March 23. Pp. 77+10 plates. (Cambridge: At the University Press.) 7s. 6d. net.

More Books to Read (1920–1926) on Social and Economic Subjects. A Supplement to "What to Read," containing Publications from December 1920 to December 1926. Pp. 80. (London: The Fabian Society.) 6d.

Proceedings of the Geologists' Association. Edited by A. K. Wells. Vol. 38, Part 1, March 21st. Pp. 144. (London: Edward Stanford, Ltd.) 5s.

Report on the Operations of the Department of Agriculture, Madras Presidency, for the Year 1925–26. Pp. ii+79+4+8 plates. (Madras: Government Press, 1926.) 12 annas.

Madras Agricultural Department. Year Book, 1925. Pp. ii+66+12 plates. (Madras: Government Press.) 1 rupee.

Astrographic Catalogue 1900.0. Sydney Section, Dec. $-51°$ to $-65°$. From Photographs taken at the Sydney Observatory, New South Wales, Australia. Vol. 7. R.A. 12^h to 18^h, Dec. $-51°$ to $-54°$, Plate Centres Dec. $-53°$. Pp. 66. Vol. 8. R.A. 18^h to 24^h, Dec. $-51°$ to $-54°$, Plate Centres Dec. $-53°$. Pp. 82. (Sydney, N.S.W.: Alfred James Kent.)

Transactions of the Geological Society of South Africa. Vol. 29, containing the Papers read during 1926. Pp. iv+160+17 plates. 42s. Proceedings of the Geological Society of South Africa. Containing the Minutes of Meetings and the Discussions on Papers read during 1926; to Accompany Vol. 29 of the Transactions, January–December 1926. Pp. iii+xliv. (Johannesburg.)

Nyasaland Protectorate Annual Report of the Geological Survey Department for the Year 1926 Pp. 6. (Zomba: Government Printer.)

Agricultural Research and Administration in the Non-Self-Governing Dependencies. Report of a Committee appointed by the Secretary of State for the Colonies. (Cmd. 2825.) Pp 101. (London: H.M Stationery Office.) 2s net.

Papers from the Geological Department, Glasgow University. Vol 10 (Quarto Papers of 1926) (Glasgow University Publications, 7) Pp. iv+5 papers Vol. 11 (Octavo Papers of 1926) (Glasgow University Publications, 8.) Pp iv+12 papers. (Glasgow: Jackson, Wylie and Co.)

The Journal of the Royal Anthropological Institute of Great Britain and Ireland. Vol. 56, July to December 1926. Pp. xi+207-437+plates 16-52. (London) 15s net.

Royal Astronomical Society. List of Fellows and Associates. Pp 52. (London.)

The Gravesend and District Scientific and Archæological Society. Proceedings, 1925–26, and Second Annual Report, April 1st 1925 to March 31st 1926, with Lists of Entomological Captures, and Flowering Plants of the District, and Descriptions of the Ancient Buildings in the Locality. Pp. 20 (Gravesend. The Borough Library.)

The National Physical Laboratory. Report for the Year 1926. Pp. 260. (London · H M. Stationery Office) 7s 6d. net

Proceedings of the Royal Society of Edinburgh, Session 1926–1927. Vol. 47, Part 1, No. 6 · The Distribution of Anopheline Mosquitoes in Scotland. By Prof. J H. Ashworth. Pp. 81-93. 1s. 6d. Vol 47, Part 1, No 7: A Study of the Fertilisation Membrane in the Echinoderma. By A D Hobson Pp 94-117. 2s. 3d (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd)

Directory of Members of the Association of Tar Distillers. Pp. 15 (London: 166 Piccadilly.)

FOREIGN.

Zentralanstalt fur Meteorologie und Geodynamik Publikation Nr. 129 Jahrbucher der Zentralanstalt fur Meteorologie und Geodynamik. Amtliche Veroffentlichung Jahrgang 1923, Neue Folge, Band 60. Pp. xxiv+A42+B40+C42+D4 Publikation Nr. 130 · Bericht uber die 11 Versammlung des Internationalen Meteorologischen Komitees in Wien, September 1926. Pp. 54. (Wien.)

Department of Commerce U.S. Coast and Geodetic Survey. Hydrography. Serial No 317: Construction and Operation of the Wire Drag and Sweep By Lt.-Comdr. J. H. Hawley (Special Publication No 118.) Pp. iii+64 (Washington, D.C · Government Printing Office.) 10 cents.

Department of the Interior. Bureau of Education Bulletin, 1926, No 22 · A Manual of Educational Legislation. Pp v+67. (Washington, D C. · Government Printing Office.) 15 cents.

Cornell University Agricultural Experiment Station. Bulletin 457: An Index Number of Farm Taxes in New York, and its Relation to various other Economic Factors By M. Slade Kendrick. Pp 47. Memoir 102. A Cytological Study of Two Types of Variegated Pericarp in Maize. By Fannie Rane Randolph. Pp 14+2 plates (Ithaca, N.Y)

Methods and Problems of Medical Education. (Sixth Series) Pp iii+275. (New York · The Rockefeller Foundation)

Diary of Societies.

MONDAY, APRIL 18.

INSTITUTION OF ELECTRICAL ENGINEERS (Tees-Side Sub-Centre) (at Cleveland Technical Institute, Middlesbrough), at 7. — Annual General Meeting.

CHEMICAL INDUSTRY CLUB.

WEDNESDAY, APRIL 20.

ROYAL METEOROLOGICAL SOCIETY, at 5.—First Report of the Committee on the Relation between Atmospherics and Weather, entitled The Range of Atmospherics. Opener of discussion, R A. Watson Watt.

NEWCOMEN SOCIETY FOR THE STUDY OF THE HISTORY OF ENGINEERING AND TECHNOLOGY (at 17 Fleet Street, E.C.), at 5.30.—F. Achard and L. Seguin: Marc Seguin and the Invention of the Tubular Boiler.

INSTITUTION OF ELECTRICAL ENGINEERS (Sheffield Sub-Centre) (at Royal Victoria Hotel, Sheffield), at 7.30. — A. Tustin · Some Magnetic Problems.

FOLK-LORE SOCIETY (at University College), at 8—Mrs. A. Morgoci: The Devil in Roumania.

THURSDAY, APRIL 21.

ROYAL SOCIETY OF MEDICINE, at 5.—Dr Gordon Holmes: Local Epilepsy (Savill Memorial Oration).

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.—Annual General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Prof. E W. Marchant. High-Frequency Currents (Kelvin Lecture)

INSTITUTION OF AUTOMOBILE ENGINEERS (London Graduates' Meeting) (at Watergate House, Adelphi), at 7.30.—W. G. Ruggins: Repairs.

FRIDAY, APRIL 22.

FARADAY SOCIETY (in Department of Biochemistry, University Museum, Oxford), at 3.30 and 5.45.—General Discussion on The Theory of Strong Electrolytes Part I. Mobilities of Ions.—P. Debye: Introductory Paper. Report on Conductivity of Strong Electrolytes in Dilute Solutions.—L. Onsager: Report on a Revision of the Conductivity Theory—K. Fajans: Refractometric Evidence for the Existence of Undissociated Molecules and Complex Ions in Solutions of Strong Electrolytes.—H. Remy: Electrolytic Transference of Water, True Transference Numbers, Ionic Mobilities and Water Sheaths of the Ions.—H. Ulich Ionic Mobilities in Non-aqueous Solvents—H. Hartley and H R. Raikes The Mobilities of the Elementary Ions in Methyl Alcohol.—H Hartley and R. P. Bell: Notes on the Debye-Huckel Theory.—D. A. MacInnes: The Ionisation of some typical Strong Electrolytes—Prof. A J. Allmand and L. J. Burrage · A Thermodynamical Study of the System Lead Chloride-Potassium Chloride-Water at 25° C—Prof. A J. Allmand: Note on the Occurrence of Points of Inflexion in the Concentration-Vapour Pressure Curve of Aqueous Solutions of certain Electrolytes

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7—Major C. H. Douglas. The Engineering of Distribution, with special reference to Finance as a Form of Organisation.

PHOTOMICROGRAPHIC SOCIETY (at 4 Fetter Lane, E.C.), at 7.—Members' Evening

JUNIOR INSTITUTION OF ENGINEERS, at 7.30—C. D. Holland: Shock Absorber Units for Land Planes.

SATURDAY, APRIL 23.

FARADAY SOCIETY (in Department of Biochemistry, University Museum, Oxford), at 9 30 A.M., 11.30 A M., and 2.15.—General Discussion on The Theory of Strong Electrolytes. Part II Activity.—J. N. Bronsted · Introductory Paper. On the Activity of Electrolytes—R. H. Fowler: Strong Electrolytes in Relation to Statistical Theory, in Particular the Phase Integrals of Gibbs.—D. L. Chapman: Note on the Theory of Debye and Huckel—N. Bjerrum Anomalies in the Theory of Solutions of Strong Electrolytes—G. Scatchard: Mixed Solutions of Electrolytes and Non-electrolytes—H. S. Harned: On the Thermodynamic Properties of a few Concentrated Salt Solutions.—F. Foxton and W. J. Shutt: The Activity of Zinc Chloride in Concentrated Solution.—C. A. Kraus · Influence of Salts on Solubility in Non-aqueous Solvents—J H. Wolfenden, C. P. Wright, N. L. Ross-Kane, and P. S. Buckley: The Use of Amalgam Electrodes for determining Activities in Methyl Alcohol—M. Randall: (a) The Significance of the Activity Coefficient, (b) Methods of Calculation of Activity Coefficient.—Prof. J. R. Partington: Electrochemical Properties of Non-aqueous Solution of Strong Electrolytes.—Prof T. M. Lowry: The Definition and Characteristics of Strong Electrolytes.—H. Millet · The Activity of Hydrogen Ion in Mixed Solvents as a Function of Environment.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Eastern District Meeting) (at County Hall, Ipswich), at 10 45 A.M.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS, at 2.30.

MINING INSTITUTE OF SCOTLAND (at Royal Technical College, Glasgow)—Annual Meeting.

CONFERENCES.

APRIL 19 AND 20.

SOCIETY FOR EXPERIMENTAL BIOLOGY.

April 19 (in Physiological Institute, Cambridge).

At 2.15—
- Prof. R. R. Gates · An Investigation of Quantitative Inheritance.
- E M. Delf. Effects of Ultra-violet Light on Plants.

At 3.45—
- J. Gray, D. Bhatia, and H. Standfast: The Growth of the Trout.
- Prof H. Hartridge and F. J. Roughton: The Velocity of Certain Biological Reactions.
- Miss Henderson and Miss Spenser. The Influence of the Corpuscle as such on the Phase of Hæmoglobin.
- A. Walton and J Hammond. Ovulation in the Rabbit
- J. B S Haldane Some Effects of CO.

At 4.30—
- Dr. G. V Anrep Inhibition as an Integral Part of Cortical Activities.
- Dr. A. S. Parkes. The Relation of the Corpus Luteum to Oestrus.

April 20 (in Zoological Building, Cambridge).

At 10 A M.—
- J. B. S Haldane, G C. Robson, C. Diver, and Dr. F. A. E. Crew: Symposium: Evolution and Heredity

At 2 15—
- J T. Saunders: Chemotaxis in Protozoa.
- Dr. E D. Adrian: The Investigation of the Sense Organs in Animals.

At 4.30—
- J Gray: The Effect of Gravity on Cell-division.
- Prof. J. S. Huxley. Artificially Induced Metamorphosis in Echinus.

APRIL 20 TO 24.

JOURNÉES MÉDICALES MARSEILLAISES ET COLONIALES (at Marseilles).—Prof. Cantacuzène: The Rôle of the Streptococcus in the Etiology of Scarlet Fever.—Dr Mayer: Recent Advances in the Treatment of Cancer.—Prof Ottolenghi: Malaria—Dr. N. Bernard · Beri-beri—Prof. Imbert. Bone-grafting.

APRIL 25 TO 28.

GERMAN SOCIETY FOR INTERNAL MEDICINE (at Wiesbaden)—Discussions on Psychotherapy, introduced by Gaupp and Fleischmann; Results of Recent Functional Investigations of the Stomach and Duodenum, introduced by G Katsch.—A joint meeting with the German Rontgen Society will be held on April 28, with a discussion on the Significance of Rontgen-ray Examination of the Lungs and Mediastinum for Internal Medicine (excluding Tuberculosis), introduced by Dietlen, Assmann, Haenisch and Lorey, and Fleischner.

SATURDAY, APRIL 23, 1927.

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The State and Industrial Research.

IN July 1915 the Government announced the appointment of a special committee of the Privy Council and the establishment of a permanent official organisation for the promotion of scientific and industrial research. As an integral part of the organisation "a small Advisory Council, composed mainly of eminent scientific men and men actually engaged in industries dependent upon scientific research," was established by Order in Council. There already existed large national responsibilities for the conduct of scientific inquiry in connexion with the fighting services, agriculture, fisheries, and medicine, but save for the last, these were subordinate activities of ministries with many other responsibilities. The unique feature of the new organisation lay in the fact that it definitely put the scientific man in the saddle, for all proposals for allocating the funds placed at the disposal of this body stand referred to the Advisory Council.

The need for such an organisation was forced upon Great Britain by the sudden realisation of its dependence on foreign countries for certain essential raw materials and manufactured goods, particularly those goods which were based upon the application of scientific discoveries to industrial processes. It was realised, moreover, that our industrial ascendancy had been challenged, if not wrested from us, by the capacity for organisation displayed by our commercial rivals, particularly Germany, and that organisation could only be met by counter-organisation.

It was in this spirit that the idea of the co-operative industrial research associations was conceived. As the Advisory Council remarked at the time:

> "so long as the Englishman treats his business house as his business castle, . . . with his hand against the hand of every other baron in his trade and no personal interest in the foreign politics of his industry as a whole, it will be as impossible for the State to serve him, whether by research or other means, as it would have been for King Stephen to conduct a campaign abroad. In the main the State can only effectively help those who help themselves."

The essential individualism of the average English industrialist was accompanied by a lack of appreciation of the function of systematic scientific research. A managing director of a manufacturing firm, and regarded as typical, informed the Advisory Council that he had no interest in research which did not produce tangible results within a year. In the face of this attitude the Advisory Council came to the conclusion that it would have to "expend a good deal of attention and money upon convincing the manufacturing world in general that scientific research is a paying proposition," and that unless the generality of British firms could be induced to alter their attitude it would have failed profoundly in one of its appointed tasks. Little, however, could be done until 1918. In the years following 1916, when the whole energies of the nation were bent to one purpose, and the whole of the existing supply of scientific workers were either engaged at the front or in urgent national services at home, it was difficult to put any policy involving individual firms into effect.

Even if the Advisory Council had had the time at its disposal and could have gained the ready acceptance by individual manufacturers of a policy of co-operative research, it was confronted with the serious difficulty of finding the research workers. Some industries, temporarily impressed with the need for men of scientific training, could not obtain them. To meet this demand, the Department instituted, a few months before the Armistice, a system of maintenance allowances to suitable students to spend two years in scientific research under direction at a university. Thus it was hoped to re-establish "a body of scientific workers of the highest rank for purely scientific work, and to enable men who intended to make some branch of industry their profession to equip themselves for scientific work in industry." In the same year, 1918, from a Million Fund put at the disposal of the Advisory Council, the first co-operative research associations were started, those for the scientific instrument and photographic industries in July, and the first of the textile research associations, that for the woollen and worsted industry, in October. In all, twenty-seven research associations have been formed under the State-aided scheme, twenty-three of which survive.

It was hoped and contemplated when the scheme was inaugurated that the industrial research associations would become self-supporting within five years—that that period would be sufficiently long to convince the subscribing firms of their utility. But some of the associations have gone into liquidation through lack of support, and most of the others, even the most successful, are still in receipt of grants. Two reasons are advanced for this by the Advisory Council: the difficult conditions during the post-War years, continued political and social unrest throughout Europe with its consequent trade depression, and the continued apathy of many of the subscribers towards research many of them regarding their subscriptions to the associations as contributions to a benevolent organisation to be reduced or withheld in bad times. Individualism of the old order has still to be broken down. British manufacturers as a whole have still to realise that co-operation is not the negation of individual effort, but that, on the contrary, it raises initiative to a higher power. Too few regard scientific research as an insurance against industrial bankruptcy. In too many instances, moreover, the subscribing firms have not the capacity to appreciate the research work which is being done. They are intellectually incapable of understanding their own problems. They confuse research with invention.

Other factors also operate against the research associations. They are competing with private consultants, many of whom have a wealth of experience and knowledge at their command, and have long enjoyed the confidence of their clients. Then again, many industrial firms prefer either to do most of their own research, if necessary submitting special problems to members of university staffs. Some of the most enlightened industrialists subscribe to the research associations, not with the primary object of submitting their principal and most promising problems to them, but rather for the purpose of obtaining information regarding the problems confronting other industrialists. The problems they refer to the research associations are often of greater academic than practical importance.

Considering the state of public opinion and the industrial unrest which prevailed at the time when most of the research associations were started, it must be confessed that the Advisory Council was unduly optimistic in expecting the associations to become self-supporting within five, or even ten, years. This is most evident in those industries in which the scientific principles underlying the processes of manufacture are little understood. The textile industries, for example, have been brought to a high standard of efficiency as the result of experience and manipulative skill, but little is known of the physical qualities of the materials used or the precise nature of the properties required in the ultimate product. Knowledge of the latter must be combined with acquaintance with the former. The research workers are therefore faced with the initial necessity of acquiring knowledge of the processes before they can hope to secure the confidence of the industries.

Laboratory research is in itself a tedious process;

further experimentation with small-scale plant is usually necessary before the final and more costly stage is reached of experimenting on a full commercial scale. The fact was recognised by the Advisory Council that nothing short of a revolutionary change in our industrial processes, based upon fundamental research, would raise British industries from the slough into which they had fallen, but the time-lag between a scientific discovery of practical importance and its industrial application was much underestimated. Commenting on a memorandum submitted by the Department of Scientific and Industrial Research, the Committee of Industry and Trade stated that:

> "The results so far achieved by the Research Associations as a whole . . . have been for the most part rather of an educational value to the industries concerned than of a kind which can be assessed in terms of actual monetary saving or gain. . . . The initial period of five years . . . has in fact proved too short a period in the case of most of the associations to yield practical results sufficiently clear and striking to convince the sceptics within the industry of the money value to their businesses of fundamental scientific research."

There is another aspect of the matter which the Advisory Council overlooks. A large number of young and enthusiastic research workers were attracted to the service of these associations, not so much by high initial salaries as by the promised interest of the work, and the prospects held out to them. Most of them fondly imagined that a change of attitude on the part of industry had brought the associations into being. But many have spent some of the best years of their life in trying to combat the prejudice against 'science' which still exists, working under difficulties throughout, and now are faced with the possibility of their work and knowledge being relegated to the limbo of forgotten enterprises.

Can the State afford to lose the results of the work of these men because industries are not yet sufficiently aware of their responsibilities to the nation? This is a question which will have to be decided before the second period of five years has elapsed. We cannot agree that it is only the industrialists themselves who are concerned with industrial research. The conduct of industry is of supreme importance to the nation as a whole. The doctrine that "the future of research associations must rest with the industries concerned, since the State cannot be expected to support indefinitely organisations instituted primarily for the benefit of the industries themselves," as enunciated by the Department, cannot be accepted. In comparison with countries like Germany—which has had far more post-War difficulties to contend with than Great Britain—and the United States, Great Britain's expenditure on industrial research is almost trifling. If industry will not equip itself for the task, it is the bounden duty of the State to decide what industrial research is required. The method of raising the funds for the purpose is a matter for the State to decide. It has already been suggested that firms should be forced to contribute to the specialised research affecting their activities. This may not be equitable, since industrial research, like pure research, is the concern of the nation as a whole. It may be found desirable to change the character of the existing associations, to group them differently or to have them centred in the various universities scattered throughout the country. Whatever is decided, the beginning, for that is all it is, is sufficiently promising to justify increased rather than diminished effort to bring home to the country as a whole the fundamental importance of research on a magnificent scale.

Rather more than ten years have elapsed since Sir Frank Heath forsook his studies of Chaucer and Canterbury pilgrims to become one of the leaders in the great pilgrimage of research. He has had to meet many difficulties. The hostility of many men of science who resented the entry of a State department into the scientific and academic world had to be fought: the apathy of industry had to be overcome. He is now about to hand over his responsibilities to Mr. H. T. Tizard, but he retires with the consciousness that his name is inevitably associated with the most successful experiment in administration to which the War gave birth.

The New Outlook in History.

The Human Adventure. (1) *The Conquest of Civilisation.* By James Henry Breasted. Pp. xxv + 717 + 50 plates + 17 maps. (2) *The Ordeal of Civilisation: a Sketch of the Development and World-Wide Diffusion of our Present-Day Institutions and Ideas.* By James Harvey Robinson. Pp. xii + 769 + 59 plates (12 maps). (New York and London: Harper and Bros., 1926.) 16*s*. net each vol.; 32*s*. net the set.

IT always arouses one's suspicions if a time-honoured institution which we have known all our days, and know to be the outcome of an immemorial growth, suddenly announces that it has become quite new. Or if a certain number of its workers set up the claim to a new and inspired method of working, we are apt, and often rightly, to regard them as charlatans or 'bolsheviks,' or whatever may happen to be the fashionable word for a dangerous revolutionary at the time. So it was, and in that case rightly, with those who promised us a new heaven and a new earth as a result of the War, and so in the minds of many is it likely to be with those who are now talking of a new history. The phrase is chiefly current on the western side of the Atlantic, and if we are not mistaken it has been most, if not first, used by one of the two authors of the beautiful work entitled "The Human Adventure," which has just appeared in two volumes, by Prof. J. H. Breasted, the eminent Egyptologist, and Prof. J. H. Robinson. Prof. Robinson, who writes the second volume, on medieval and modern times, is principally identified with this new gospel of history, but Prof. Breasted, who supports him with a massive knowledge of archæology and the ancient world, is at one in thinking that history in our time has entered into another and far more important phase of its development.

What, then, are these recent changes? Are they sufficient to make us think that history has put on a substantially new character? What are the bearings of this new history, new at least in the minds of some who study and teach it, and how far do these two volumes by Messrs. Breasted and Robinson fulfil the ideals that they set before them?

The inquiry, as we might expect before starting, very soon reveals itself as closely similar to that into the evolution of any other great branch of human activity. Take, for comparison, religion, or science, or art. They seem in their fully developed form to differ so widely from their first beginnings that we are apt to think them entirely changed and that we have achieved, or are on the threshold of, a religion or a science—new in kind. Yet, looking back, we can trace a continuous growth and always find somewhere an earlier germ of what we thought was quite new. So in this appearance of a 'new' history one can find antecedents and authority in the works of previous thinkers for all the new ideas and material that are now coming in with a flood. Thucydides and Herodotus could give us examples enough; what is new is the amplitude of the material, the spread of a similar spirit of inquiry from one branch or nation to another; above all, the valiant attempt to see all the facts as part of one process the understanding of which is a matter of essential and transcendent importance for civilised men. Understood in this sense, we may well allow the claim of a 'new history' to its professors and gratefully acknowledge our debt to Messrs. Breasted and Robinson for their contribution to it in these volumes.

The distinguishing points in the outlook on history which these books so admirably illustrate are mainly these. In the first place, and dominating all the rest, the story is regarded as that of civilisation as a whole, and not merely of the political development, whether of one nation or of any grouping of nations. This involves not omitting wars or the building of states, but seeing these activities as part of the larger process through which mankind has passed from the state of isolation, ignorance, and collective powerlessness in which we first discover our human ancestors, to the comparative unity and vast collective power and knowledge in which we now live.

Three aspects of history at once emerge into prominence as soon as this point of view is taken. One is the importance of the fundamental early inventions and advances in culture which archæology has lately been revealing with a striking similarity from all quarters of the globe. Prof. Breasted is satisfactorily emphatic on this side of his subject, and puts first ploughing, the use of metals, and the invention of writing and the calendar, among the benefits which the ancient Egyptians conferred on their neighbours. It will be noticed that the priority which he assigns to Egypt, not only over the west but also over all the civilisations farther east, lends support to the recent school which turns to Egypt as the nursery of all civilisation. It should also be remembered that such particular questions as the relations between Egypt and Babylonia, or the antiquity and originality of the civilisations of India and China, are detailed matters for further research. They do not affect the main position of putting in their due place these and other aspects of man's contact with Nature as well as with his fellow-man.

Following the same line of thought into later times, the new outlook in history lays stress on the vital importance of the evolution of scientific thought in building up mankind. In this, again, as we might expect, our authors show a right appreciation of the relation of the facts, although one would be glad to see more space assigned to that aspect of progress which has hitherto received practically no treatment at all in general histories. Thus Mr. Robinson points out that the scientific advance which began to be rapid in the seventeenth century, produced also a general spirit of reform which has dominated the west ever since; and in a concluding chapter he shows the supreme importance of scientific thinking in promoting the forward-looking habit, based upon continuity with the past. It would be interesting to trace how it is precisely this spirit which inspired the reforming monarchs of the eighteenth century—Frederick the Great, Joseph II., and the rest. The limitations of their success, and the limitations, equally marked though due to other causes, of the philosophers of the Revolution, form one of the most interesting and instructive studies in history, far outweighing the glamour of Napoleon's career, which still occupies the forefront of the stage even in such enlightened books as these. Napoleon, and many like him, passed over the world as a hurricane, clearing away, no doubt, much ill-founded vegetation and structures; but the work of the thinkers goes on steadily all the time, correcting its mistakes and bringing at last to fruition ideas that ignorance and passion may impede for generations.

It will be understood at once that as soon as we transfer our main attention in history to the general growth of civilisation, rather than the political development of particular States, our view gains in universality as well as continuity with the past. The things that matter most are those which we share with others and not those which divide or distinguish us. It all turns on that, and the acceptance of this fundamental truth does not involve the lowering of mankind to a level of dull and monotonous mediocrity. Eminences will remain, and may be just as beautiful and varied if they arise from a broad and well-based plateau as if they stand isolated and likely to be submerged in a rising ocean. The fundamental facts of civilisation are of this common and connecting kind. Not only in their inventions and their arts of life, but also in their maxims of morality and their earliest ideas of religion, we find ourselves at home when we trace origins, whether in India and China or in Mexico and Peru. Going back we come together, and going forward we may hope to integrate history and the world at large in the same spirit, a spirit not of uniformity or of degradation, but of a common humanity, realising itself in varied forms.

On this matter again it must be said that Prof. Robinson might have imported a little more of the 'eternal spirit' in looking at his facts without depriving them of a tittle of their interest and actuality. The League of Nations is made to appear in his pages as if it were merely as a part of the Treaty of Versailles, a sequel useful and important, but only a sequel, of the War. It is that of course, but, *sub specie aeternitatis*, it is far more. It is the necessary sequel of the process of unifying the world, in which science and its applications had played so large a part, both in the "Conquest" and the "Ordeal" of civilisation. The "Ordeal" is in fact the question whether the achievements of science in the mechanical sphere are to be used for the furtherance or the destruction of the civilisation which has been conquered; the sharpened razor and the more massive hammer will be the more destructive to life if they are not wisely governed; and wisdom, like science, is a collective thing, the highest manifestation of common sense. The League of Nations, whether there had been a great war or not, must have been born, and was being born, to give voice to this common sense.

One would have welcomed a little more explicit statement of these truths in the second volume, and a little less of somewhat personal matters in the post-War chapters; even the excellent and almost full-length portrait of Mr. Ramsay MacDonald does not reconcile one to this want of balance.

On the whole, however, the work in both volumes is well done and is unquestionably the best popular presentation of general history which we have yet acquired in English. Prof. Robinson is more fluent and philosophic; Prof. Breasted is more solid, and adds more to our knowledge. But he does it in the most attractive way, with admirable pictures, maps, and cross references. The work is a notable step forward in the much-needed operation of informing the general public of the latest results of historical research into the ancient world and of the new and broader outlook in the modern.

F. S. Marvin.

Elementary Astronomy.

The Elements of Astronomy: a Non-Mathematical Textbook for Use as an Introduction to the subject in Colleges, Universities, etc., and for the General Reader. By Prof. E. A. Fath. Pp. viii + 307. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1926.) 15*s*. net.

THIS book is a welcome addition to the rapidly growing mass of astronomical literature. It is, in the main, well arranged, clearly written, and adequately supplied with excellent illustrations and diagrams. There is nothing revolutionary or in any way unconventional in its general plan, and while the most recent researches have been taken into account, the author has not yielded to the temptation of ascribing to intrinsic importance the relative prominence which may actually arise only from their nearness. The book may be generally recommended as an accurate and interesting outline of present-day astronomy.

It is unfortunate, however, that Prof. Fath has attempted the impossible task of achieving two irreconcilable results in a single volume. His work is intended both as a text-book and as a book for the general reader. The characteristics of successful works of these two types under our present system of education are antagonistic. A text-book must be primarily an aid in preparing for examinations, and should therefore present knowledge in the form of 'quanta' which can be reproduced on the examination paper in a period of twenty or thirty minutes. It must draw a perfectly sharp line between what is known and what is unknown, and concentrate attention entirely on the former. This is very regrettable, but it is nevertheless true. The general reader, on the other hand, is interested in astronomy only in relation to life as a whole. He does not want chapter and verse, but only broad results and lines of thought. In brief, while the text-book should describe the individual pebbles on the shore, the book for the general reader should deal only with the relation of those pebbles to the undiscovered ocean of truth from which they have been retrieved.

Prof. Fath's book necessarily suffers from the attempt to unite these two classes of work. As a text-book it lacks something of the precision which is desirable. The treatment of the subject matter is in parts somewhat sketchy, and is almost entirely non-mathematical. It is true that the book is intended for college freshmen, but the college curriculum which includes the teaching of the principles of refraction of light and the methods of determining time, latitude, etc., to students with no knowledge of the rudiments of trigonometry, is open to severe criticism. There is, too, a complete absence of suggestions for practical exercises. It is most desirable that students—and especially beginners—should be encouraged to do things for themselves, and even in those colleges unprovided with simple spectroscopes, transit and equatorial instruments, a great deal may be done with the old-fashioned celestial and terrestrial globes. It will be noticed that these defects of the text-book are merits of the book for the general reader, who, however, will not welcome the division of the chapters into short numbered paragraphs, each with its own heading.

Allowing for the impossibility of his aim, however, Prof. Fath has probably made as satisfactory a compromise as is possible. A book may fall short of its ideal and still be extremely valuable. We regret that Prof. Fath did not confine himself to a single purpose—or, better still, write two books—but we do not wish to convey the impression that the book is a failure. It will probably be found most useful to the secondary school teacher who, not having to teach astronomy as a definite subject, is yet sufficiently interested in the wider aspects of education to keep his pupils in touch with the general principles and achievements of the most humanistic of sciences. The general reader also who is not repelled by the text-book-like appearance of the paragraphs will read the volume with both pleasure and profit. About two-thirds of the book is concerned with the solar system, so the older astronomy has not been neglected for the more sensational developments of the new. Having regard to the four subdivisions of astronomy defined in paragraph 6, however, the uninstructed reader will probably conclude that the observation of the planets belongs to astrophysics. A fifth subdivision—descriptive astronomy—might well have been included.

There are the few inevitable mistakes, of which only the more serious need be mentioned. Since a paragraph has been devoted to the 'spectrum' of a comet, it should have been stated that the spectra of the head and tail differ from one another. The proposed classification of the nebulæ on the basis of spectral type alone is scarcely satisfactory, and the term 'disintegration' of matter, which is used throughout to indicate the probable source of stellar energy, does not convey the true idea of annihilation. The reader who has had faith in the ingenuity of men of science will be surprised by the statement on p. 39 that a converging and a diverging meniscus (not here so called) "cannot be distinguished by their names alone." Finally, Fig. 31 is an almost incredibly erroneous diagram, in which rays of light are suddenly deviated in the midst of a homogeneous medium. It is the most striking example we have met with of the danger of thinking in terms of single rays instead of pencils of light. The book is well produced, and contains few misprints. 2½ lb., however, is an excessive weight for a book of 307 pages.

H. D.

General and Special Mineralogy.

Lehrbuch der Mineralogie. Von Prof. Dr. P. Niggli. 1. *Allgemeine Mineralogie.* Zweite Auflage. Pp. xvi + 712. 24 gold marks. 2. *Spezielle Mineralogie.* Unter besonderer Mithilfe von Prof. Dr. L. Weber. Zweite Auflage. Pp. xvi + 697. 30 gold marks. (Berlin: Gebrüder Borntraeger, 1926.)

None of the foreign guests of the Mineralogical Society on the occasion of its recent fiftieth anniversary was more heartily welcome than Prof. Niggli of Zurich. It is therefore with especial interest that we open the new and greatly enlarged edition of his text-book of mineralogy in two handsome volumes.

The first of these, which deals with the general principles of the subject, is not only a monument of industry and research, but it also displays everywhere the resources and originality of the author. It deals with crystallography at considerable length, paying especial attention to the atomic configuration, as revealed by the Röntgen rays. More stress than usual is laid on the physical characters of crystals, though, as may be supposed, it is their optical properties that are treated in the greatest detail. The principles of crystal chemistry are carefully explained, and space is even found for the subject of glasses and colloids.

The student who has mastered the contents of this volume will have acquired an undoubted mastery of the theory of the subject, though it may be open to question whether it is best for him to owe his training to one great compilation, however accurate, logical, and complete it may be. He might get a broader grasp of the subject if he studied, under the guidance of his teacher, the expositions of different workers who have made themselves responsible for recent advances. There would then be less danger of his adopting stereotyped methods of treatment.

Some years ago, Prof. Hilton introduced the principle of 'rotatory inversions' in describing the symmetry of certain classes of crystals: that is to say, rotations resulting in the coincidence of all crystallographic lines, but with the directions reversed of lines having different properties in opposite directions. This valuable conception, based on the nature of crystal structure, has been since extended to the relation between the component parts of some twinned structures, but it finds no place even in this most comprehensive of text-books.

The second volume, dealing with the individual minerals, is no less remarkable. In it, also, special stress is laid on crystallography, which is treated in a somewhat original manner. Crystals belonging to systems with relatively low symmetry are considered to be distorted examples of forms with higher symmetry and classified accordingly. Thus a group of cubic and 'hypocubic' crystals includes not only fluor, which is cubic, but also calcite, which is rhombohedral. Curiously enough, Prof. Niggli does not place the monoclinic baryto-calcite in the same category in spite of the remarkable resemblance of its crystallisation to that of the rhombohedral carbonates. The felspars, too, are referred to hypocubic axes. Pyroxenes are, as one would expect, hypotetragonal, and amphiboles hypohexagonal. These and other similar affinities have long been recognised and were studied in detail by Fedorov. Indeed, the author might have noted an additional link between the cubic and trigonal systems in the fact that fluor and halite, though cubic in their angles and optical characters, exhibit occasionally a development of faces which seems to indicate rhombohedral or even lower trigonal symmetry. But the use of such affinities as the basis of a classification, cutting across the established systems and classes of crystals, which the author still recognises, and branching out into intricate subdivisions, is calculated to confuse the student, while those who are already familiar with crystallographic principles experience a sense of bewilderment when they have struggled through the volume. Yet it undoubtedly contains a store of interesting facts and suggestions.

With all its idiosyncrasies this remarkable book should be found on the shelves of every teacher of mineralogy and crystallography, but he will probably hesitate to place it in the hands of the members of his classes.

J. W. E.

Our Bookshelf.

Introductory Electrodynamics for Engineers. By Prof. E. Bennett and Dr. H. M. Crothers. Pp. ix + 665. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1926.) 22*s.* 6*d.* net.

This book aims at giving a thorough grounding to students of superior ability who have a keen interest in their subject. From many points of view it is deserving of high commendation, but the reviewer rather hesitates to recommend it to students in Great Britain, until at least they have passed their examinations. The difficulty is that the authors have introduced some radical changes into ordinary nomenclature. In some cases these changes are desirable, but in other cases they will be apt to lead to confusion at the present time.

The entire treatment of electric and magnetic theory is given in terms of a single system of units instead of three systems. This system, the rationalised practical system, has been freed of the 'irrational' π factors and of the multiplicity of troublesome conversion factors by three expedients: (1) By using the ampere turn and the ampere turn per cm. as the units of magnetomotive force and of magnetic intensity respectively; (2) by using the weber and the weber per sq. cm. as the units of magnetic flux (induction) and of magnetic flux density; (3) by assigning to the permittivity, p_0, of free space such a value that Coulomb's law becomes

$$f = \frac{q_1 q_2}{4\pi p d^2},$$

where f is measured in *dyne-sevens* (10^7 dynes), q_1 and q_2 are in coulombs, and p is the permittivity of the medium in which the charges are immersed. The value of p_0 in free space is taken as $8 \cdot 85 \times 10^{-14}$. Accepting this notation, we can say that the book is well and clearly written. It contains many useful examples, and several of the methods of discussing well-known theorems are novel and instructive.

Recent Advances in Physiology. By Prof. C. Lovatt Evans. Second edition. Pp. xiii + 370. (London: J. and A. Churchill, 1926.) 12*s.* 6*d.* net.

The appearance of the second edition of this little volume within a few months of the first speaks well for its reception. It is, in fact, an excellent presentment of our knowledge of certain selected aspects of physiology. The author describes it as an "Elementary Text-book of Advanced Physiology"; but we feel sure that most of the chapters could be read with profit by the average medical student. The author has seized the opportunity presented by the need for a second edition to bring the book right up-to-date. Thus Harington's work on the structure of thyroxin, the active principle of the thyroid gland, is referred to, and a short but adequate account is given of the effect of insulin upon the normal organism. In this connexion the work of Best, Dale, Hoet, and Marks is mentioned. These authors have been able to show that the sugar which disappears from the blood under the action of insulin can be completely accounted for, either by combustion or by conversion into glycogen in the muscles.

Perhaps the two most useful chapters are that on the mechanism of postural reflexes and the functions of the labyrinth, in which an account is given of the work of Magnus, and the one on conditioned reflexes, describing the methods of research and the results obtained by the Russian physiologist, Pavlov. In neither case is there any adequate summary of this most important work extant in the English tongue. Perhaps the least satisfactory chapter is that on the physical aspects of the physiology of muscular contraction, which might be made clearer by a fuller description of elementary principles. On the other hand, the author is quite at home in the chapters on the blood, especially in that dealing with its reaction. Altogether, this is a most interesting book, and can be thoroughly recommended to all interested in the subject of physiology.

Die Enzyme: Wirkungen und Eigenschaften. Von Ernst Waldschmidt-Leitz. (Die Wissenschaft: Sammlung von Einzeldarstellungen aus den Gebieten der Naturwissenschaften und der Technik, Band 76.) Pp. xvi + 233. (Braunschweig: Friedr. Vieweg und Sohn A.-G., 1926.) 14 gold marks.

The object of the author of this short and excellent account of the enzymes is to illustrate the general principles of enzyme action and the results of recent work on the separation and the partial purification of enzymes by a series of examples, rather than to attempt a complete account of the subject. Accordingly the first hundred pages deal with general matters, the remainder of the book being devoted to a brief consideration of the various groups of enzymes.

The close association of the author with the recent work of Willstätter (to whom the book is dedicated) adds interest and authority to his fascinating account of the methods of preparative enzyme chemistry. The quantitative measurement of enzyme action is here seen to be essential for all true progress in our knowledge of the nature of enzymes. On this fundamental question the author supports the conception of Willstätter that enzymes are definite and separable chemical individuals, probably consisting of a colloidal 'carrier' and a specifically active group.

The book is written in a clear and interesting manner, is well up-to-date, and is provided with a good index and sufficient references. A. H.

Soil Characteristics: a Field and Laboratory Guide. By Prof. Paul Emerson. Pp. x + 222. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1925.) 12*s.* 6*d.* net.

Methods of soil investigation are now so numerous and varied that a volume including some description of the more important of these fills a definite gap. The features of special soil types are not dealt with, but as a preliminary the procedures adopted in soil surveying and sampling are outlined, together with methods of classification and mechanical analyses. Analytical methods for the determination of various soil constituents are given in detail, special attention being devoted to the preparation of equipment. The physics and biology of the soil are not dealt with so fully, but sufficient is given to direct the attention of the student to the main aspects of the problems involved.

The bibliographies are conveniently placed at the end of the various sections, but consist mainly of references to American papers. Numerous laboratory experiments are suggested and outlined wherever possible, with the intention of supplying training on a good working basis for the determination of the characteristics of whatever soils may come under consideration.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

Recession of the Tahitian Coral Reefs.

It is generally assumed that coral reefs are still growing, and when the outer slope is fairly well covered with living corals there seems to be no doubt about the matter. Yet in Tahiti and the adjacent island of Moorea there is no doubt that even with a fair abundance of living coral, the reefs are slowly going back.

Pending the publication of a full account, the following are evidences for this unexpected conclusion:

(1) The form of the outer slope, its regularity and smoothness, absence of all sand and debris—down to 10 or 12 fathoms it is absolutely clean.

(2) Its being cut into by trenches at short intervals. These are very clearly under erosion, their vertical sides and flat bottoms being scoured clean of every growth. These extend from where the surf breaks just under the raised edge of the reef to 10 fathoms, where they open out on to the general slope. For the lower 7 or 8 fathoms of their course they lie at the bottom of ravines the sides of which are covered with corals to exactly the same extent as the open slopes, but for all that, growth has not sufficed to make the ravine's sides vertical or anywhere near that. These trenches are not in the least like outgrowing tongues or buttresses; they do not resemble at all those described and mapped in the Report on Funafuti, for example.

(3) The strong scour on those slopes is shown also by the fact that it is the corymbose Madreporas (Acropora), which are the dominant corals, this form of growth being a special modification for the purpose of raising the colony above the fatal sand rasp of the bottom. This became clear to me from my experiments with pearl oysters in the Red Sea. These corals are all, as it were, planted out at intervals of a foot or two over the surface, never riotously crowded as on the reefs of the Red Sea or the lagoon reefs of Tahiti.

(4) Coral growth ends quite definitely at from 10 to 12 fathoms down, instead of the usual 30 fathoms or more.

(5) The final and conclusive proof is that some of the stones which lie in the trenches are rounded pieces of basalt from the hills. One finds such stones at intervals on any part of the reef, on both sides of the lagoon, either lying on the eroded outer flat or bedded into the vertical walls of the shoreward lagoon reefs. It is clear that the reef was originally continuous from shore to edge, and that the lagoon is a comparatively recent secondary formation. The stones on the outer slope would have been buried deeply in coral if there had been any extension of the reef seawards since the opening of the lagoons cut off the supply from the island. They prove more than that growth has come to a standstill since that event, for the stones could not lie on this slope for long: they must in time be swept downwards. Those now in view have been exposed comparatively recently by the erosion of the coral in which they were embedded.

(6) Though there is no coral rock in all Tahiti raised above sea-level so high as to be dry land, there is in three places in Moorea. (One of these was reported as coral to Capt. Cook by his officers, but Agassiz was so badly served as to be told that the rock was volcanic.) All three are on the outer sides of islets of coral sand on the reefs, and near the outer edge, and all were originally the *outer shallow part of the lagoon floor*, which is now two feet above water-level and in an extraordinarily perfect state of preservation. Their position so near the present reef-edge affords another proof that there has been no extension seawards since that lowering of the ocean surface which left these lagoon floors dry, and exposed the shelves along the foot of cliffs in so many islands of the Pacific, the Marquesan and Society Islands included.

(7) Unlike the other islands of the group, Tahiti is not completely surrounded by a 'barrier' reef. (The reason for the use of inverted commas is given above.) There are no surface reefs for miles off the north-eastern corner of the island, but soundings show that the reefs are there, but under about 5 fathoms of water. These might be (1) reefs growing up which have not yet reached the surface; (2) reefs submerged by local subsidence, but the chart itself shows clearly that they are not; (3) parts of an original shelf upon which all the reefs were founded. The examination of the shores within them shows that there was once the usual maritime flat here as round the rest of the island, which has now disappeared, leaving relics here and there to show its former existence, and the comparison of the reefs themselves with those which reach the surface shows that they are exactly the same but for the *removal* of the upper five fathoms or so.

I find it difficult to account for this reduction in the vigour of coral growth, but one factor has probably been the laterisation of basalt, its conversion from hard rock to that red clay so conspicuous on the slopes, which in floods causes all the streams to run red. This does not, however, seem possible as the whole explanation, and there may be biological changes involved, such as in the species of coral dominant, the balance between the organisms which build and those which destroy reef material, or even in coral physiology.

In Tahiti and Moorea, at any rate, it is clear that the age of corals is past. Is it possible that this is true of the world in general? In 1902 the writer showed that the great reef of tropical East Africa is nothing but a shelf cut by the sea into the great mass of raised coral which forms these coasts; in the Red Sea, part of the breadth of the reefs is formed in the same way and part by the growth which has occurred since the elevation, but where the distinction can be made out the latter is comparatively small. In reading most descriptions of reefs one is struck by the disproportion between the amount of growing material present now and the huge structure raised by growth in the past.

The possibility that the latest of the coral ages is now passing or passed, introduces another complication into this ever-fascinating study, and the possibility of former extensions of the present surface reefs is one to be borne in mind in future investigations.

I desire to acknowledge the assistance received from the Government's Grant Committee of the Royal Society and the managers of the Balfour Fund of this University, which made possible the exploration of which this is the more important result.

Cyril Crossland.

The Zoological Laboratory,
Cambridge,
Mar. 3.

Advantages of the Ring Method for the Study of the Surface Equilibria of Colloidal Solutions.

The letter of Prof. Harkins, concerning some of the methods used for measuring surface tension,[1] contains a statement about the ring method which may mislead the reader; and the addition of a few words to it may therefore be worth while.

My efforts in the past five years have tended to emphasise the importance of a phenomenon which had been overlooked so far, namely, the decrease in the surface tension of colloidal solutions as a function of the time. Although a few exceptions have been found, the great majority of colloidal solutions obey this law, including dyes, proteins, metallic sols, gums, etc. It was known that the static value of the surface tension was different from the dynamic value, but it was generally agreed that the adsorption in the surface layer took place almost instantaneously.[2]

The study of the delayed adsorption, which can be followed step by step over periods of hours through the consequent decrease in the surface tension, can obviously only be observed by using a method permitting a proper control of the time. As the surface tension of a colloid solution begins to decrease as soon as it is no longer stirred, its value depends on the time elapsed since the last stirring. By using the instrument which I call for short a 'tensiometer,' according to a technique first described in 1922 and improved in 1925,[3] it was possible to obtain the values of the surface tension about 1/10 of a second after the stirring. These values, for sodium oleate solutions diluted to 1/25,000, were only slightly less than the value of the surface tension of pure water, namely, 68 to 69 dynes at 20° C. Measurements taken at ten seconds' interval showed the decrease which, under the conditions of the experiments (2 c.c. in watch-glasses), took place proportionally to the time. After thirty seconds the value was 55 dynes, and after one minute, 42 dynes. The curve expressing the decrease then assumed a logarithmic shape, and the static value was attained, in this case in five minutes, at 36·6 dynes. At higher dilutions, the time required to reach the static value is greater; for example, at 1/100,000 under the same experimental conditions, the static value was equal to 32·1 dynes and was reached in twelve minutes. It is obvious that the time required to reach the equilibrium depends on three main factors: concentration, mobility of molecules (function of the viscosity of the solution), and ratio $\frac{\text{surface}}{\text{volume}}$ of the container. It may vary with different solutions in watch-glasses (2 c.c.) from twenty minutes (pure serum) to three hours or more (serum diluted 10,000 to 20,000 times).

Such measurements are very easy and simple to perform with good accuracy by means of the tensiometer. If a drop method, even though highly improved, were used, it would require waiting two or three hours, sometimes more, for every drop to form and fall. If it be assumed that three drops were sufficient to obtain a satisfactory accuracy, which is an optimistic view to say the least, this would mean, with one instrument, six hours instead of two, or nine hours instead of three, and an accurate control of this time would be exceedingly difficult. The determination of a complete adsorption isotherm would require days. Moreover, the estimation of the total adsorbing area, which is an important factor, would not be an easy matter and would involve the calculation of the surface of the drop itself. I have shown[4] that under certain conditions absolute minima of the value of the surface tension are observed at very high dilutions (at 1/750,000, 1/1,220,000, and 1/1,390,000 in the case of 2 c.c. of sodium oleate in watch-glasses), and that these minima can be shifted by altering the area of the adsorbing surfaces (by adding glass beads, for example). The hanging-drop method does not readily lend itself to such experiments.

Another interesting phenomenon was described in 1922,[5] namely, the 'antagonistic action' of one colloid upon another. When a strongly surface-active substance, such as sodium oleate, is added to a solution of colloids with larger molecules or particles (proteins, metallic sols), a sudden drop in the surface tension is observed, as would be expected, but this drop is immediately followed by a rapid rise which can be followed step by step with the tensiometer, and, under certain conditions, the original surface tension is reached after seven minutes. When measurements are made every thirty seconds, a perfect adsorption isotherm is obtained.[6] It is doubtful whether this phenomenon could be studied at all with any drop-weight method. Yet it is important, since it gives a method whereby adsorption may be studied quantitatively with great ease and rapidity, and whereby the area of adsorbing surfaces may be evaluated. This problem is being investigated at present in our laboratory.

A slight modification of the tensiometer makes it possible to measure interfacial tensions.[7] With this instrument we have obtained adsorption isotherms at the interface between paraffin oil and sodium oleate solutions, as a function of time;[8] the action of temperature at the interface between water and ethyl ether and water–carbon disulphide was also investigated with great facility, and gave *positive* temperature coefficients.

I have mentioned a few of the results which were found as a direct consequence of the use of the ring method improved so as to render it practical and very rapid. In the biological field this method has enabled us to study the processes of immunity in animals, and to reach certain conclusions which are not devoid of interest. On the other hand, the absolute value of the surface tension of water obtained without any correction with the du Noüy tensiometer agrees within ±0·1 dyne with the values published by the best authors (72·6 dynes at 18° C.). Furthermore, although criticised by some, the ring method has nevertheless in recent years aroused so much interest that Prof. Harkins himself, whose authority in this field is unchallenged, has found it necessary to give it a great deal of attention, and leads us to hope that he and his collaborators will soon be able to give a corrected formula which will reduce the errors to less than 0·1 per cent. This correction, although uncalled for in the case of water and most aqueous solutions, will undoubtedly establish the superiority of the ring method over all others, so far as convenience, rapidity, reliability, and adaptability to different problems are concerned. I trust I have made it clear that it has already scored in the particular case of colloids.

P. Lecomte du Noüy.

Rockefeller Institute for
Medical Research.

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[1] W. D. Harkins, Nature, Nov. 20, 1926, p. 732.

[2] W. M. Bayliss, "Principles of General Physiology" (London, 1918), p. 56. H. Freundlich, "Capillary Chemistry" (New York, 1926), pp. 50-52.

[3] P. L. du Noüy, "Surface Equilibria of Organic and Biological Colloids," Am. Chem. Soc. Monographs (New York, 1926).

[4] P. L. du Nouy, *Phil. Mag.*, 1924, 48, 664; "Surface Equilibria of Organic and Biological Colloids" (New York, 1926), pp. 86 and fol.

[5] P. L. du Nouy, *J. Exp. Med.*, 1922, 36, 115.

[6] P. L. du Nouy, "Surface Equilibria of Organic and Biological Colloids" (New York, 1926), pp. 155 and fol.

[7] P. L. du Nouy, *J. Gen. Physiol.*, 1925, 7, 625.

[8] P. L. du Nouy, "Surface Equilibria of Organic and Biological Colloids" (New York, 1926), pp. 174 and fol.

Efficiency or Effectivity?

One of the most difficult problems which confronts all investigators who have to deal with man as a worker, is the assessment of his fitness to produce. The accurate determination of the degree of fitness of the man to perform his work has never been satisfactorily elucidated, so that reliance is placed most frequently on the measure of his productiveness as shown, say, by the number of articles produced, the quality of his work, the time taken to perform selected operations, alterations in skill of performance, etc. Further, when it is desired to refer to any alteration, either by way of enhancement or diminution, in the individual's capacity to carry on any particular operation, it is generally said that the man's *efficiency* is increased or diminished.

It is true that modern usage, as indicated by the "New English Dictionary," for example, authorises a definition of the word efficiency as "fitness or power to accomplish, or success in accomplishing, the purpose intended"; and as another meaning it gives "efficient powers or capacities." Colloquially the word efficiency is commonly used, with perhaps even wider significance, as a synonym for power to perform, for the conduct of business with energy and with the minimum of waste, not only on the part of single individuals but also of groups of workers.

It has, of course, long been recognised that the term efficiency is neither a scientific nor, in the light of modern knowledge, an apt one by which to refer to the individual's change in capacity. The engineer has appropriated to his own technical vocabulary a word which had long been in common use, and as a result it has come to have a very definite connotation in engineering, and even in physiological, science. When used by the engineer it is, as a rule, qualified by some adjective indicative of the particular type of efficiency to which he is referring. Thus he may speak of mechanical or thermal or thermodynamic efficiency.

The physiologist, too, has investigated the efficiency—in the engineering sense it would be the over-all thermal efficiency—of the human body and has arrived at very definite results. While it is open to question whether a mode of calculation suitable in the case of the development of energy in a mechanical apparatus, like a steam engine, is applicable to the series of metabolic processes common to the human body, where, it must be remembered, food serves not only for yielding energy but also for the repair of tissue waste, no serious objection can perhaps be taken, provided the limitations of the method are kept in mind.

As an alternative to the displacement of the term efficiency from the engineer's vocabulary, a feat which would be practically impossible of accomplishment, we must be prepared either to use the word with a double significance or else find a substitute. It is clear that the common usage of the term in connexion with everyday labour of all kinds cannot be justified. We have no right to refer to the increased or diminished efficiency with which a man performs a specific piece of work if we, at the same time, take no cognisance of the data which must be determined before the actual efficiency of production may be considered. The use of the word efficiency is then simply a loose colloquial way of referring to a general condition of human well-being with absolutely no reference whatsoever to the true scientific meaning of the term.

When we speak of efficiency in this general way, what we want to express is, that the individual in question is performing his work in the most effective and useful fashion. In other words, the idea we wish to convey has nothing to do with that other determinable factor involved in man's productive powers, namely, the ratio of his energy expenditure in the form of useful work to his intake of energy or to his total expenditure of energy, but simply with the degree of effectiveness with which the work is done.

In view, then, of the confusion of ideas which must arise when the same word is employed to define two very different types of phenomena in man, it is suggested that it would be best to employ two words. Let the word *efficiency* be confined, whether fully justified or no, to the ratio of the energy exchange in the performance of work, but in order to cover the much wider field, where there are no special but innumerable general physiological or physical determinants, and where we wish to speak of enhanced or diminished capacity to perform, it is suggested that a word like *effectivity* might be more fitly employed. Such a word commits us to no underlying single series of physiological phenomena, but is perfectly general, and refers merely to the sum total of the factors which lead to effective production, and it can therefore be suitably applied to a wide range of activities of individuals or groups of individuals. The word has been selected as the most suitable from a number of alternatives, all, more or less, expressing the same general idea.

As a practical illustration of the difference between "efficiency" and "effectivity" one of the experiments which I published in conjunction with Prof. F. G. Benedict may be cited. We determined the efficiency of a highly trained subject doing most strenuous work on a bicycle ergometer for more than 4 hours. His efficiency at the start was 23·1 per cent., and in the observation made just before the experiment ended, due to the impending collapse of the subject, it was 21·3 per cent. One can state, then, in this extreme example, that although there was but a small reduction in the subject's efficiency, his effectivity at the end was nil.

It may be remarked in conclusion that certain of the German workers have found the same difficulty, but, so far as I am aware, none of them has suggested a term to cover the idea which it is desired to express. Effectivity, if it find acceptance, might be utilised by German workers as 'Effektivität.'

E. P. Cathcart.

The University,
Glasgow.

The Mechanism of the so-called 'Posterior Sucker' of a Simulium Larva.

The manner in which a Simulium larva fixes itself to rocks and water weeds in very rapid running water has hitherto been a matter of dispute among naturalists. Some have supposed that the so-called 'posterior sucker' of a Simulium larva functions in the same way as does the sucker of a leech, and it is only recently that Tonnoir (*Ann. Biol. Lacustre*, 11, pp. 163-172; 1923), not finding any muscles inserted in the middle of the disc, doubted its utility as a true sucker and ascribed the function of attachment to the hooks alone. Dr. Puri (*Parasitology*, 17, pp. 295-369; 1925), to whom we are indebted for a monograph, "On the Life-history and Structure of the Early Stages of Simuliidæ" (1925), has demonstrated the presence of fairly strong muscles connected with the centre of the disc, and he has observed "that they contract when the larva fixes itself by its posterior end." But he further points out that "in spite of the presence of these muscles the larva cannot fix itself effectively without the further help of the sticky salivary secretion; a fact which may mean that the saliva helps to fill up the spaces between the hooks and thus to form a complete rim all round."

In determining the function of the 'posterior sucker' it seems to me that undue importance has been attached to the presence or absence of muscles in the centre of the disc.

Recently, while preparing a public lecture for the fourteenth annual meeting of the Indian Science Congress at Lahore, on "Animal Life in Torrential Streams," I made a number of observations on many kinds of animals living in swift currents. An entire week was devoted to the study of Simulium larvæ, which I found in great abundance both on the water plant *Eriocaulon miscrum* Kaern., and on bare rocks in a small stream below the Dumpep Bungalow in the Khasi Hills. A close study of the habits of these larvæ has led me to conclude that the posterior appendage does not act as a sucker, but fixes itself with the help of hooks alone. These are capable of gripping firmly a cluster of silk threads (the sticky salivary secretion) which the animal secretes on the spot where it intends the posterior appendage to be fixed. The presence of strong muscles in connexion with this appendage is necessary, for, in order to disengage the hooks from the salivary secretion, a strong and sudden muscular pull is required. This action is readily noticed when a larva, moving from one place to another, is examined under water. The muscular action noticed by Dr. Puri at the time of attachment of the sucker is a manipulation on the part of the animal to enable it to fix its hooks effectively in the secretion.

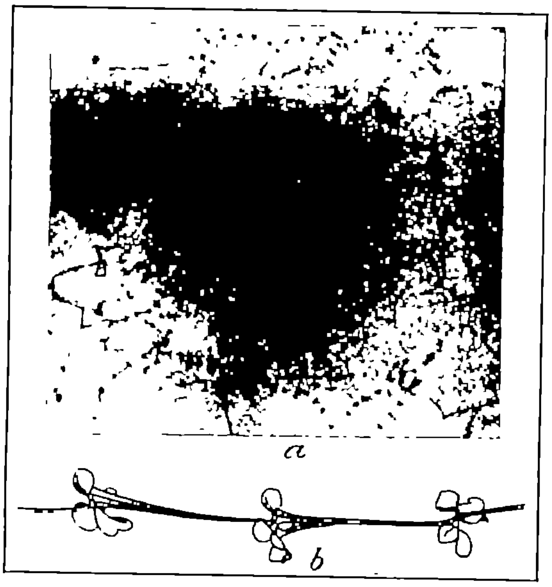

FIG 1.—Tracks of sticky salivary secretion left by Simulium larvæ on a glass slide. *a*, Photograph of the tracks; *b*, a portion of the same much enlarged.

If a larva is allowed to crawl about on a slide, it is noticed that the progression is effected by the help of the thoracic proleg and the salivary secretion. A small amount of the salivary secretion is poured out and the hooks on the proleg grapple on to it. The larva goes on pouring out a thread of saliva as it progresses. A number of these larvæ were allowed to crawl about on a slide and the method of their progression was beautifully illustrated by the track of the secretion they left behind them (Fig. 1).

SUNDER LAL HORA.

Indian Museum, Calcutta,
Jan. 19.

The Formation of Twin Metallic Crystals.

IN the discussion in NATURE (Jan. 22, p. 120, and Mar. 12, p. 392), Mr. McKeehan has taken exception to statements of Carpenter and Tamura in a paper on the above subject on the grounds that the method of formation of twins depicted by them brings atom centres too close together. Twinning by reflection about a plane is considered, and the discussion hinges on the precise location of this plane with reference to the planes of atoms. Geometrically, a twin crystal of this type consists of two individuals united symmetrically about a plane, which is not one of systematic symmetry but is a possible crystal face (Tutton, "Crystallography and Practical Crystal Measurement," 2nd ed. vol. 1, p. 500, where it is also stated that the plane of twinning is "usually one with low indices and indeed very often a primary face"). In view of the improbably small distance of approach of atoms required by Carpenter and Tamura's hypotheses, it appeared to be worth while examining the effect of adding to the above *geometrical* law of twinning the *physical* conditions (1) that the reflection plane can only be one such that the operation of twinning does not bring atom centres closer to one another than the closest distance of approach of atoms in either component of the twin, and (2) that the components of the twin have in common at least one plane of atoms. Briefly, these conditions imply minimum stress and maximum continuity of structure.

Subject to these assumptions, it may be shown that for a simple cubic lattice, twinning of the type considered can only take place about {100}, {110}, {111} or {200}, of which the first two and the last are systematic planes of symmetry and lead only to cases of parallel growth in holohedral forms. For a body-centred cube such as α-iron there is no plane, other than {100}, {110}, {200}, which fulfils condition (1), but {211} requires a very small compression and might be permissible. For a face-centred cube, {111} is the only plane other than {100}, {110}, {200} and {220}. In the case of the diamond structure the only plane other than symmetry planes is that mentioned by Mr. McKeehan (NATURE, Jan. 22), namely, a plane parallel to {111} cutting the cube diagonal at a distance ⅛th of its length from the origin and bisecting a line joining two atoms which are separated by the closest distance of approach—the co-ordinates of the atoms being $000, 0\tfrac{1}{2}\tfrac{1}{2}, \tfrac{1}{2}0\tfrac{1}{2}, \tfrac{1}{2}\tfrac{1}{2}0$. $\tfrac{1}{4}\tfrac{1}{4}\tfrac{1}{4}, \tfrac{1}{4}\tfrac{3}{4}\tfrac{3}{4}, \tfrac{3}{4}\tfrac{1}{4}\tfrac{3}{4}, \tfrac{3}{4}\tfrac{3}{4}\tfrac{1}{4}$. In this structure the components of the twin have two planes of atoms in common, and the reflecting plane lies midway between them.

So far as the metals which crystallise on a face-centred cubic lattice are concerned, the above results seem to be correct. Gold, silver, copper, lead, platinum, and iridium are stated by Dana to twin about {111}. Diamond and silicon also twin on this plane. Iron is stated to twin on {111}, contrary to the result obtained above; but as this material passes through a transformation in cooling, the existence of twinning in the α-modification would have to be confirmed by X-ray measurements. I understand that twins are rarely, if ever, observed in the body-centred cubic metals.

The application of the above hypothesis to the case of compounds is too complicated to be dealt with here; but sodium chloride and potassium chloride, in which the atoms are situated at the corners of a simple cube, ought to twin on {111}, as they are in fact observed to do (Groth). The case of calcite can be derived from this, for when the sodium and chlorine atoms are replaced by calcium and carbon respectively and the cube distorted to a rhomb, {100} becomes a possible twin plane and is commonly observed. In general each case would have to be considered separately in conjunction with a knowledge of the structure obtained by X-rays.

G. D. Preston.

The National Physical Laboratory,
Teddington, Middlesex,
Mar. 16.

X-ray Diffraction in Liquids.

In order to find experimental support for the theory of X-ray diffraction in liquids put forward some three years ago by C. V. Raman and K. R. Ramanathan (*Proc. Indian Association for the Cultivation of Science*, vol. 8, p. 127, 1923), extensive studies have been undertaken in the authors' laboratory of the phenomena observed when a pencil of monochromatic X-rays passes through a layer of fluid, particularly with the view of determining how the effects are influenced by the physical condition and the chemical nature of the substance under investigation. The photographs here reproduced (Fig. 1, *a* and *b*) were obtained in the course of work on this line by one of us (C. M. Sogani) and represent the X-ray liquid-haloes of hexane and cyclo-hexane respectively. The fluids were contained in cells with very thin walls of mica, and the *K*-radiation of copper from a Shearer X-ray tube was used.

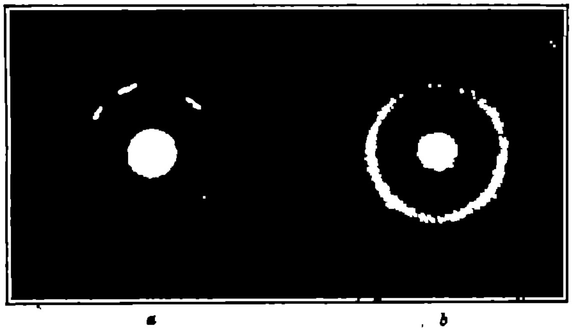

Fig. 1.—X-ray diffraction haloes of liquids. *a*, Hexane; *b*, cyclo-hexane.

The differences between the two patterns are sufficiently striking; cyclo-hexane shows a bright and sharply defined halo with a very clear dark space within, while hexane, on the other hand, shows a less intense and relatively diffuse halo, the inner margin of which is not sharply terminated but extends almost up to the direction of the incident rays. These differences indicate very clearly the effect of the geometrical form of the molecules on the X-ray scattering by a liquid. From an X-ray point of view, cyclo-hexane consisting of ring-formed—though arbitrarily orientated—molecules has a nearly homogeneous structure, while on the other hand the elongated shape and varying orientations of the molecules in hexane cause it to be much less homogeneous in X-ray scattering. This explanation is supported by the observation that the diffraction halo of benzene resembles very closely that of cyclo-hexane.

It is very interesting to contrast these facts with the optical behaviour of the three liquids with regard to the scattering of ordinary light. Optically, hexane and cyclo-hexane are far more nearly similar to each other, and differ strikingly from benzene, the depolarisation of the scattered light being small for hexane and cyclo-hexane and relatively large for benzene. Here, evidently, the geometrical form of the molecule is of much less importance than its chemical character.

Further studies of the liquid-haloes for various organic substances of the aromatic and aliphatic series, and specially with the long-chain compounds, are in progress.

C. V. Raman.
C. M. Sogani.

210 Bowbazar Street,
Calcutta, India, Feb. 10.

Prehistoric Archæology in Yorkshire.

It is difficult to see what connexion there is between the East Riding Antiquarian Society forming an out-door museum in the Old Tithe Barn at Easington, Yorkshire, and the fact that the Hull Corporation has the Mortimer collection of prehistoric antiquities in its possession, though not on proper exhibition (Nature, April 2, p. 494).

The Tithe Barn at Easington has been handed over to the East Riding Antiquarian Society by the Ecclesiastical Commissioners, and the Society is taking the responsibility of its restoration and preservation, and is converting it into a museum of old farming appliances, at its own cost. The only part the Hull Corporation is playing in the matter is that it is permitting its Museum Director to select such objects as are likely to be suitable for exhibition, and placing them in the Tithe Barn, where they will be in much more appropriate surroundings, while the space in the other Corporation museums which they now occupy can be more suitably utilised.

The case against the Hull Corporation is scarcely so black as Mr. Crawford paints it. Certainly the Mortimer collection was purchased from the family, on advantageous terms, and the money given for its purchase to the Hull Corporation by Colonel G. H. Clarke, who stipulated that so important a collection should not be merged in any of the other museums, but should have a building to itself. This condition the Corporation accepted, and this condition Colonel Clarke quite properly is pressing the Corporation to fulfil. Unfortunately, soon after the purchase the War broke out, and as the Driffield Museum was likely to be wanted for military purposes, the collection had to be packed and removed to Hull, where a large house was rented for its reception. Afterwards this was required for other purposes, and the collection was again removed into a warehouse adjoining one of the museums. The matter of the proper accommodation of the collection has been brought up many times, but the conditions which obtained during the War and afterwards made building a separate museum a difficult proposition. However, at the present moment negotiations are on foot for the purchase of a large building in the centre of the city which will admirably answer the purpose, and personally I hope that this will be concluded.

It is scarcely correct, however, to say that the specimens are all in packing-cases. As a matter of fact, some little time ago the Corporation erected a special large workshop for the proper restoration, labelling, and display of the Mortimer collection, and also appointed a junior assistant whose whole time is occupied in the work. In addition, most of the important bronze age pottery, the bronzes and other more valuable specimens from the tumuli, are on temporary exhibition at the Albion Street Museum.

However, may I sincerely thank Mr. Crawford for writing his letter, as the matter has been taken up rather vigorously by the local press as a result, and, I trust, now the attention of the Hull City Council has been directed to the matter, something tangible may accrue.

T. Sheppard
(Director.)

The Municipal Museums,
Hull, April 6.

Phytophagic or Biological Races in Insects.

Mr. Meyrick points out in his letter (Nature, Mar. 12, p. 388) that the idea of biological races is by no means a new one, and, judging from his last paragraph, he seems to think that the principle may be of but little importance as a factor in the production of new species. It may not be out of place to direct attention to the fact that the phenomenon appears to be very widespread among the Insecta.

As regards the Lepidoptera, besides the cases mentioned by Mr. Meyrick, the Codlin moth (*Cydia pomonella*) (H. J. Quayle, 1926) is an interesting probable example observed in the United States; while on the experimental side the production by Pictet (1911) of an inherited modification of feeding habit in *Lasiocampa quercus* is of much interest, although the results are by no means so conclusive as those of Dr. Harrison. The present writer is now working on moths of the genus Hyponomeuta from this point of view, and although the experiments are not yet sufficiently far advanced for publication, it seems that to postulate the existence of biological races adapted to special food plants offers the simplest explanation of the facts so far observed.

Among Rhynchota the capsid *Plesiocoris rugicollis* (Petherbridge and Husain, 1917) is another probable case, while in Homoptera the experimental work of P. Marchal (1908) on the coccid Lecanium offers a very close parallel to that of Dr. Harrison. In Diptera, to mention only one case, Cameron (1914) working on the anthomyid, *Pegomyia hyoscyami*, definitely proved the existence of at least two biologic strains within the one species.

Similar results have been obtained among Coleoptera, the best known being that of Schroeder (1903) on the Salix feeding beetle, *Phratora vitellinae*. This again showed a result very close to that of Dr. Harrison on Pontania.

The above are just a few of the more striking cases known, but enough has been said to show that the phenomenon is probably very widely spread among phytophagous insects and, as Mr. Meyrick justly remarks, can scarcely be described as a new principle. Possibly, however, it is of more importance in the evolution of new species than Mr. Meyrick appears to think.

In this connexion it is interesting to note that Dr. M. Hering in his recent book, "Biologie der Schmetterlinge" (1926), says: "Wir können also festhalten: Polyphag in der Raupe sind phyletisch alte Formen; Monophagie ist eine Erwerbung jüngeren Datums." If this generalisation is correct it would seem that phytophagic races may have been the means by which monophagous species were evolved.

W. H. Thorpe.

Zoological Laboratory,
Cambridge.

The Geissler Discharge in Argon.

There is now a considerable literature dealing with analysis of arcs, and of glow discharges from a hot cathode, in which Langmuir's improved method of using an exploring electrode has been employed. It has been shown by one of us that, as would be expected, the same method can be applied to the glow discharge between cold electrodes (*Proc. Camb. Phil. Soc.*, 23, p. 531; 1927). This work was of a preliminary nature, and the results were, to a certain extent, ambiguous. We have now repeated the experiments under better conditions, in argon, and have confirmed the earlier results.

With a low current density and conditions not far different from those corresponding to a normal cathode fall of potential, there is a sharp maximum in the concentrations of both positive ions and electrons at the middle of the negative glow. The electric field is reversed between this region and the edge of the cathode dark space, and two groups of fast electrons appear. There are here present electrons with energy corresponding to a large fraction of the full cathode fall of potential. The Faraday dark space extends almost to the anode, and the electric field in it is small at the higher pressures (0·8 mm.) and strongly reversed at the lower pressures (0·2 mm.). We find that the ionic concentration gradients are sufficient to carry the current by diffusion through the reversed electric field, as in low voltage arcs.

Our curves for the collector characteristic in the cathode dark space are difficult to analyse, and it may be questioned if any method of using an exploring electrode may legitimately be applied to this region of the discharge, because of the disturbance indicated by the 'shadows' thrown by the collector.

K. G. Emeléus.
N. L. Harris.

Wheatstone Laboratory,
King's College,
University of London, Mar. 14.

Relation between the Reciprocal Impenetrability of Matter and Pauli's Exclusion Principle: A Correction.

Some paradoxes which have occurred to me and have been pointed out to me also by some of my colleagues (especially Dr. Fues, Copenhagen), show that the fundamental statement of my letter (Nature, Feb. 5) published under the above title, is incorrect. It is not true that the reciprocal impenetrability of the molecules allows only of the Heisenberg-Dirac determinant solutions, and excludes all others. On the contrary, *all* the symmetrical and antisymmetrical characteristic solutions which existed for absolutely penetrable molecules remain for a (not one-dimensional) gas with molecules having a radius very small compared with the mean distance; only the characteristic values are a little changed, and the characteristic functions undergo a deformation in the immediate neighbourhood of the 'diagonal spaces.' If, therefore, the Pauli principle is valid not only for the electrons of an atom but also for the translatory motion of gas molecules, with radius almost zero, then such a remarkable relation between the molecules cannot be so simply explained by wave mechanics as my mistake led me to believe.

P. Ehrenfest.

The Property of Dilatancy.

The theory of dilatancy, the characteristic of the deformation of granular materials, was given by Osborne Reynolds before the Aberdeen meeting of the British Association on Sept. 10 and 15, 1885, and later in a modified form before the Royal Institution, Feb. 12, 1886. These presentations were published in the *Phil. Mag.*, vol. 20, pp. 469-481, 1885, and in Nature, vol. 33, pp. 429-430, 1886, and later in Reynolds's collected papers.

Since then there has apparently been little discussion of the phenomenon, and the few references I have were found accidentally in papers bearing no hint in their title of a discussion of this subject.

I shall be grateful to any one who will furnish me with references to papers in which the phenomenon is discussed.

L. B. Tuckerman.

Bureau of Standards,
Washington, Mar. 12.

The Acoustics of Buildings.[1]

By Dr. G. W. C. Kaye.

In view of the examples of acoustically defective halls which abound in our towns and cities, it is the more surprising to find that the fundamental principles of architectural acoustics were clearly appreciated nearly a century ago in Great Britain by a number of workers. Then, as now, it was realised that the two defects most frequently met with in large auditoriums are (1) echoes and (2) excess of reverberation; that is, the tendency of an arrested sound to persist unduly by multiple reflection at the boundaries, owing to their deficient absorptive properties.

So long ago as 1835, at a meeting of the British Association at Dublin, we find Reid recognising reverberation as a prevalent acoustic defect and suggesting remedies in the shape of more absorbent walls by increasing their roughness or irregularity, or by hanging draperies. He also stressed the advantage of excluding superfluous space.

Dickens's acoustic powers of observation are exemplified in "Martin Chuzzlewit," written in 1843. In Chap. ix., in describing the houses in the neighbourhood of Todger's boarding-house, he relates how

> "these mansions, now only used for storehouses, were dark and dull, and, being filled with wool, and cotton, and the like—such heavy merchandise as stifles sound and stops the throat of echo—had an air of palpable deadness about them."

Roger Smith, in his "Acoustics of Public Buildings" (1861), remarked that: "In empty houses a great reverberation is perceptible which diminishes as the floors are covered with carpets and the rooms filled with furniture." Tyndall, in 1868, in evidence before a Select Committee of the House of Commons, stressed the value of a low ceiling as a reinforcing device, and the influence of an audience and of draperies in quenching the after-sound. During the proceedings of this committee, it was elicited that flock paper applied to the walls of a reverberant room had proved an effective remedy.

Again, Johnstone Stoney (1885) described how he tested a room which had its walls papered over a lining of canvas, the canvas being a short distance in front of the framework over which it was stretched. From his experiment he inferred that concert halls or public rooms could be effectually freed from echo effects by the simple expedient of lining the walls and ceiling in such a manner.

Rayleigh, in the second edition of his "Theory of Sound" (1896), gave the first mathematical treatment of the absorption of sound waves by porous rigid bodies. He clearly recognised the inevitability of reverberation in large rooms with non-porous boundaries, and suggested a remedy in the shape of thick carpets, curtains, etc.

The ground would seem to have been well prepared for a systematic investigation on auditorium acoustics in England, but it was not forthcoming; and it is to the pioneer work of the late Prof. W. C. Sabine, of Harvard University, that we must turn for the first elucidation of the main practical problems, particularly as regards reverberation. His "Collected Papers on Acoustics" extend over the period from 1900 to 1915, and his work and that of others has attracted considerable attention both in the United States and Germany.

As a consequence, although much remains to be done, there is now sufficient volume of experience to enable the main acoustic requirements of a building to be satisfactorily met before the erection of the building is even commenced.

The principles are simple and straightforward, but much scepticism and apathy will have to be dispelled in Great Britain to prevent a repetition of the acoustical failures conspicuous in a number of modern halls. The Press reflects the view commonly held that architectural acoustics is a gamble. For example, the *Times* on July 24, 1922, remarked that: "Broadly speaking, it may be said that the acoustic qualities of a hall or room cannot yet be predicted"; and again in its issue of Oct. 19, 1926, it was stated that "there is no means of studying the acoustic properties of a building which does not exist, or exists only on paper."

However, within recent years the subject of applied acoustics, as a quantitative science, has become the object of study at a number of centres in England, notably the Signals Experimental Establishment at Woolwich, the National Physical Laboratory at Teddington, and the Building Research Station at Watford.

We may proceed to review some of the acoustical characteristics of a building.

Echoes.

As regards echoes, it is found that an echo becomes noticeable when the reflected sound lags behind the direct sound by more than about $\frac{1}{15}$ second. If the lag is less than this, the reflected sound will serve to reinforce the direct sound. This is an argument in favour of limiting the heights of the ceilings of council chambers and the like to not more than about 35 ft., as the ceiling is the only reinforcer common to every speaker no matter what his location. The House of Commons serves as an illustration.

Thus the question of echoes will not arise except with large halls, though even a slight echo may contribute to poor hearing. The effect is not likely to be pronounced in the absence of smooth concave surfaces, such as a dome or barrel vaulting, which lead to uneven sound distribution and are definitely inimical to good acoustics. Such surfaces should be broken up, for example, by coffering, and the objectionable reflections absorbed by suitable means. A satisfactory distribution of sound may normally be anticipated within a hall of approximately rectangular section. Furthermore, interference phenomena are not likely to be of any moment, particularly in the case of speech.

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[1] Abstracted from three Tyndall Lectures delivered at the Royal Institution in November 1926.

The reflecting characteristics of the boundaries of an auditorium may, with a little experience, be approximately appraised from a geometrical study of sections based upon the optical laws of reflection. Two other methods are available for use with scale-models. In one, first used by Sabine in this connexion in 1913, the progress of an actual sound-pulse in the model is displayed by the well-known method of spark illumination. In the other, use is made of the analogy between water ripples and cylindrical sound waves, a method which appears to have been first suggested by Scott Russell at a meeting of the British Association in 1843. Each method has its advantages, and both give results which, although predictable in the main by geometrical methods, show also the spreading of waves by diffraction beyond the optical limits. Incidentally, either of the experimental methods is more convincing than the geometrical when for any reason it is desired to provide ocular demonstration of the acoustic properties of a particular architectural design.

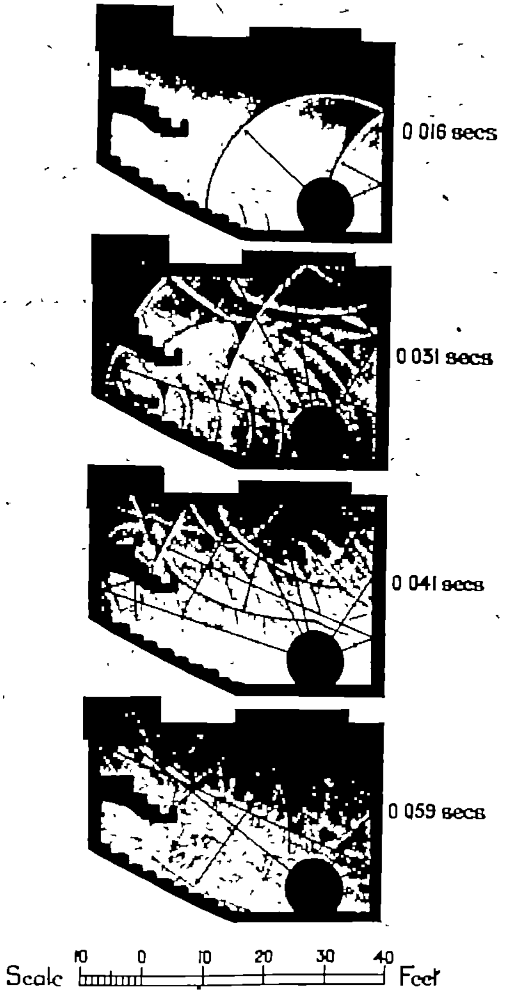

Fig. 1.—Sound-pulse study of the lecture theatre at the Royal Institution.

Fig. 1, taken at the National Physical Laboratory by Mr. Fleming, shows the progress of a sound-pulse in a central vertical section of the theatre of the Royal Institution, which was erected in 1800 and is of acknowledged acoustical excellence—a view subscribed to by Faraday in evidence before a Select Committee in 1835. In the figure, arrows drawn from the position of the source show the tracks of certain selected wave fronts.

Reverberation.

As already remarked, the common defect of large auditoriums is undue reverberation. Rigid non-porous walls have, on Rayleigh's estimate, a higher reflecting power for sound than the best mirrors have for light. Thus, unless absorptive materials in some form are provided, the rate of dying away of a sound in a large hall will normally be so protracted as to cause confusing overlapping of successive sounds or syllables emitted at ordinary rates.

It was primarily the work of Sabine that has made it possible to measure the proportion of incident sound energy absorbed by a material (that is, the absorbing power), or to predetermine the amount of absorbent necessary to ensure acceptable reverberation in a hall. If a steady source of sound in a room is suddenly stopped, then Sabine showed that the duration of audibility (when determined under proper conditions) is an important acoustical characteristic of the room. He established the relation that this reverberation period (as it is called) is proportional to the volume of the room, and inversely proportional to the total absorbing power of the boundaries and contents. If we work in square feet and seconds, the constant of proportionality is $\frac{1}{20}$. It may be noted that the relative linear dimensions of a room are not now regarded as material, except perhaps for extreme shapes.

The degree of reverberation is all-important. A certain amount is pleasing and helpful; excess leads to greater loudness but increased confusion; insufficient results in enfeeblement and staccato effects which are displeasing to hearers and, furthermore, impart a sense of deadness or absence of power to a speaker or singer. A great variety of observations have been carried out on the optimum reverberation periods to suit different conditions. Briefly, it may be said that for speech in relatively small halls (up to, say, 50,000 cubic feet) a period of about one second is preferred, the value increasing up to about two seconds for the largest halls. Cultivated musical opinion agrees in preferring rather longer periods for music, depending on its character and volume.

It may be remarked that in large cathedrals and churches, reverberation periods up to six or seven or more seconds are common, a condition which dates back to medieval times and is responsible for certain features of the services—the characteristic choral and organ music, the intoned liturgy, and the frequent inaudibility of the speaking voice.

The remedy for excessive reverberation in a room is either to reduce the volume, if practicable, say, by lowering the ceiling and partitioning off unnecessary large recesses, or to increase the sound-absorbing power of its surfaces by the use of absorbents such as felt, quilting, wood-wool, aerated plaster, fibre board, carpets, curtains, upholstery, etc. In some cases the disposition and shape of such absorbents can be so chosen that they will also serve to suppress undesirable reflections.

In passing, it may be added that there does not appear to be any recorded scientific evidence that stretched wires exert any beneficial effect in auditorium acoustics, though examples may still be found.

Loudness.

In addition to the defects of echo and reverberation, the question of inadequate loudness will almost certainly arise in a large building, particularly in the case of speech. Experience agrees that the range of the unassisted speaking voice of average strength is of the order of 50 feet, that is, provided the hearer is so situated as to receive a direct 'ray' of sound. At greater distances it becomes necessary to provide reinforcement, either by reflection from suitable surfaces, or by an electrical loud-speaker system. In view of the increasing use that is being made of public address systems, it should be realised that their main office in a large hall is to provide adequate loudness in the remoter parts. Further, by placing the loud-speakers in suitably high positions, troublesome ceiling echoes may sometimes be obviated. The system is not a remedy for excessive reverberation; on the contrary, the increased loudness adds to the confusion. The system may be a valuable corrective when steps have been taken to reduce reverberation by introducing absorbent material—a procedure which of itself unfortunately decreases the volume of sound. It has, of course, to be recognised that in some cases the rendition of an amplifier and loud-speaker may not be wholly acceptable to a cultivated ear. The amplification should not be excessive or unnatural effects will result, nor should the different loud-speakers be widely separated or effects of repetition akin to echo will be produced. In Great Britain the system has so far been installed notably in large cathedrals, *e.g.* Liverpool Cathedral, Westminster Abbey, and Bath Abbey. An alternative method of amplification is employed in the House of Lords, where certain seats are equipped with ear phones, for the purpose of affording assistance to individual auditors who suffer from deafness.

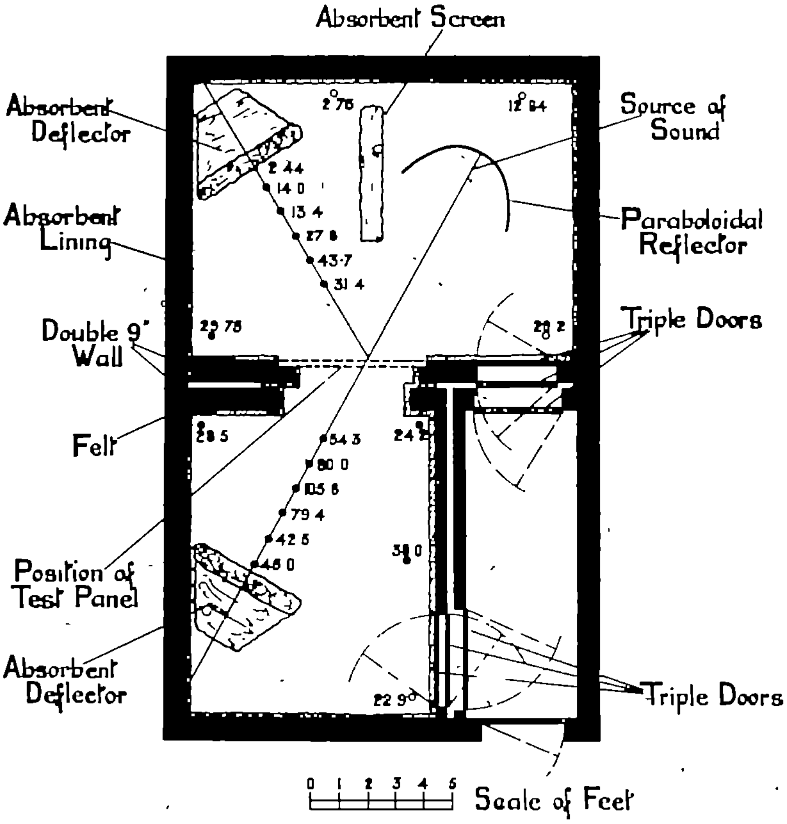

Fig. 2.—Sound-proof rooms at the National Physical Laboratory, Teddington, for measurement of transmission and reflection coefficients.

Absorption Coefficients.

We see that for a room to attain its optimum reverberant condition, it is necessary to arrange that the various exposed surfaces shall possess in the aggregate the requisite absorbing power. We thus require to know the absorption coefficient or the absorbing power of unit area of each material present.

Various methods have been employed for measuring this coefficient of absorption for building and other materials. One method is to measure the change in the reverberation period in a calibrated test chamber when a known and suitably large area of the material is introduced under proper conditions. In a second method, a beam of sound is directed towards a test specimen mounted as a panel in an aperture in a sound-proof wall, and the proportions of the incident sound which are reflected or transmitted are measured. Fig. 2 illustrates the use of this method by Dr. Davis and Mr. Littler at the National Physical Laboratory. In the case of small samples, another method is available for measuring the reflecting power. This is based upon measurements of the ratio of the intensities at the nodes and antinodes of the stationary waves in a tube, one end of which is closed by the test material.

Figures for the absorption coefficients of a number of materials have been determined by

Sabine and others. Per square foot, they range from 1·0 for an open window, 0·5 for hair-felt one inch thick, to about 0·01 for plaster or glass. Each isolated member of an audience is equivalent in absorbing power to about 4½ square feet of open window. In the majority of cases the audience constitutes the most absorbent feature in a hall, so that the reverberation period is markedly responsive to the size of the audience.

Sound-proofing.

The question of sound-proofing is often of great practical importance. As regards the transmission of air-borne sounds, they are best arrested by having the walls sufficiently massive and rigid. In the case of structure-borne sounds, it is necessary for effective insulation to interrupt the continuity of the structure. For example, a sound-proof room may well be constructed like an inner box which is floated on insulators on the structural floor, and everywhere insulated from the structural walls and ceiling.

To conclude what is only a partial survey of the subject, it is evident that neglect of the established principles may lead to defective acoustic conditions which may prove to be incurable after a building is erected. Preventive treatment is preferable to curative, and architects should be prepared to allow acoustic requirements some share in influencing their designs.

Lister and Physiology.[1]

By Sir C. S. Sherrington, O.M., G.B.E., F.R.S.

It is indeed fitting that we should recall on this commemorative occasion the contributions made by Lister to physiology. His very earliest scientific papers were all physiological. He may be said to have entered by way of physiology his surgical researches which were to achieve so much. His first paper was entitled "The Contractile Tissue of the Iris." It was work done by the microscope, which he used for the study of function rather than of form alone. It appeared in 1853, in the first number of the first volume of the now well-known *Quarterly Journal of Microscopical Science*. Lister was then twenty-five years of age. That the microscope should be his instrument for his maiden voyage of discovery was but natural in the son of his father, Joseph Jackson Lister, that remarkable man, who leaving school early for the business he conducted so successfully, yet found time to cultivate optics to such purpose as to devise and give to the world the achromatic microscope. Lister's earliest paper, this on the iris, supplied the first full and correct description of the radiating muscle dilating the pupil of the eye. It thus made a lasting mark upon its subject.

Lister's second paper, of a few months later, dealt likewise with involuntary muscle; this time in the skin, where had been recently discovered the arrector muscles of the hairs; a discovery which Lister confirmed and in several respects extended.

We may be struck by the remoteness of these Lister's first themes both from surgery and indeed from actual practice—they are frankly academic. I think we have to picture him a young man to whom the thing that really mattered was to engage at once upon research, caring less what in particular the research might be; a young man so ardently curious about Nature, especially animate Nature, that he turned enthusiastically to the problem that came first to hand. These papers in the simplicity of their text seem to reflect the Quaker upbringing of Lister's home. There is already that sobriety of expression which, characteristic of Lister all his life, made yet the more impressive his own self-restrained statements of his great results later on. No man in his career had more excuse for, more justification for, hyperbole of phrase than had Lister, and no man ever indulged in hyperbole less than did he. It is therefore of significance when the young author allows himself an expansive adjective, as when he writes "the grand discovery of plain muscle-cells," "the beautiful muscle of the iris." We feel these expressions to be, from him, not mere phrases. An abiding interest of these youthful papers is their revelation of attributes in Lister's, so to say, original nature. Any reader of them must be struck by his power of penetrative and faithful observation, his patient enthusiasm, a restless testing of authority by observed fact, and an unhesitating self-submission to wherever the truth might lead.

His third paper, still physiological and on the same theme, smooth muscle, followed some four years later. The cellular nature of that tissue had been denied; Lister returned to its further proof. He furnished it overwhelmingly. Forty years afterwards the then foremost authority on this tissue wrote of this paper of Lister's as being still not only abreast but in several respects ahead of other subsequent papers on its subject.

This work proved, however, to be Lister's farewell contribution to that particular theme. To him by then much had happened and was happening to compel his main interest elsewhere. His scientific enthusiasm had indeed definitely orientated itself towards a chosen quest in the great field of the unknown. His spirit of inquiry had found a direction of overpowering interest to it. In his own words, written to his father, he had fallen in love with surgery; and with that widely detailed and highly technical art and calling prospectively spread before him, the genius within him impelled him to study not so much this or that particular skill or difficulty, but the fundamental and all-pervading process of inflammation itself as being for him the one prime and central problem for investigation.

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[1] Discourse delivered in the Robert Barnes Hall of the Royal Society of Medicine on April 6.

Thenceforward Lister's physiological researches were merely side offshoots from that pathological tudy engaging his main thought; thus his paper n the nervous control of arteries, distinguishing etween the immediately local and the more istant effects of a stimulus, and especially of an ritant stimulus upon the blood-vessels. The local ffect, he concluded, was independent of the ervous system, but with a surrounding zone of ffect mediated by nerve, a finding closely sugestive of present-day views. Another paper was that on the pigment cells of the frog's skin, the ells on which the animal's well-known colour hanges depend. Lister concluded the shift of pigment to be an active shift of the pigment grains within the cells themselves, and the way in which he consolidated and marshalled his evidence for hat proof is a striking example of his thoroughness as an investigator. There is little doubt that from letailed study of these pigment cells Lister gained much of that vivid and intimate conception of cell-life struggling against irritant agents which nformed and directed his surgical strategy afterwards.

Another of his physiological investigations concerned the inhibitory nature of certain visceral nerves. He wrote: "I have been led to make an experimental inquiry into this so-called inhibitory agency because it appears to me to have an ntimate bearing upon the question how inflammation is developed through the medium of the nervous system at a distance from an irritated part." His main conclusion was that inhibition resulted from more energetic action of those same nerves which, when working mildly, are excitatory. Then, and still more closely related to his pathological inquiries, followed two papers on clotting of blood, confirmatory, as he himself remarks, of his conclusions arrived at about inflammation.

These papers and the year 1862 conclude practically the tale of Lister's researches devoted directly to physiology. Perhaps their main interest now is their revelation of their author in his earlier research career. Conspicuous in them is capacity for noting detail and the rarer power of sifting out from it the broader meanings. Another of their qualities is the conscientious pains to observe for himself phenomena which many would be content to take on trust from the excellent descriptions already given by others. Lister as an observer was satisfied by nothing less than seeing for himself, and his eye never staled. There was also genius. What but genius could have whispered to him to make a frontal attack upon what then seemed the inevitable and universal process of suppurative inflammation itself. Surely in his choice of that problem there was genius, the humility of genius to set itself to begin at the very beginning, the daring of genius, to set itself to rebuild from the foundation. A further quality is the scientific courage which knows no fear except to lose the truth. Moreover, even at this stage, though he might appear engaged on diverse problems, he was in fact centred upon one, of which from his point of view the several were but several aspects.

Thus from these early papers we see that in reality, almost from the outset of his career, he had not only found but had also flung himself upon what was to be his life-work and his life's problem—a problem we may imperfectly subsume under the one broad term 'inflammation.' That was the study which he was to follow to a practical solution so magnificently, and in so doing display what these earlier papers had less opportunity for showing, the splendid power of establishing and systematically pursuing to its consequences a great generalisation. Hence from these earlier researches we can see spring that triumphant career of experimentation and observation, in the laboratory and the ward, which, with a really surprising speed of mastery, winged surgery for that which she is to-day, a far-flighted angel of healing the civilised world over.

These papers, valuable though they are, whose features we have been examining, do not exhaust—far from it—the gift made by Lister to physiology. In addition to and beyond them he enriched it with the contribution of enhanced means towards its own most cherished aims. He put into the hands of physiology for all time a superlative refinement of its method, and made possible observations otherwise impossible. Sir Berkeley Moynihan has recently eloquently insisted on the importance of surgery as a means to discovery. In physiology, how could Pavloff have achieved his epoch-opening study of the digestive processes except by leaning upon Lister's surgical principles? Was it not by means of Lister's surgical principles that Ferrier initiated his study of localisation of cerebral function? How could the physiologists of Toronto less than four years ago have bestowed upon diabetic sufferers that merciful remedy insulin, had it not been for the legacy of operative principle and science bequeathed to them and to the whole world by Lister?

Lister's own words leave us in no doubt as to the source of rejoicing it was to him that among benefits accruing from his work was this of an enlarged scope and power for physiology and experimental medicine. He dwelt, both in public and in private, upon the need and importance of such experimentation for the progress of knowledge necessary to civilisation. He rejoiced that he had contributed to man's power in that way. Indeed, the experimentalist owes to Lister an instrument of research the beneficent future of which the boldest imagination may well halt to set limit to.

Of the gifts from Lister to humanity, one which the experimentalist is ever mindful of with especial gratitude is that, while helping man to mastery over disease alike for animal and man, he contributed to free that necessary experimentation from the infliction of pain. Man, sacrificing animal life as he does to satisfy the material needs of human kind, has the right to regard the intellectual and moral impulse driving him to mitigate and dominate disease, as justified in its resort to animal experimentation. He feels the more fully justified in doing so, and takes that step with a clear conscience, because largely owing to Lister it can be taken without inflicting pain or suppuration.

Thus it is that through years to come, after, indeed, it may be the actual papers contributed to physiology by him have become matter chiefly for the historian and the antiquarian, Lister will still receive unfailingly his meed of commemoration from the physiologist and experimentalist, and in a manner which to himself would of all ritual and offering have been the most congenial—namely, in their daily observance and trust of methods which he discovered and inculcated, and in the practice of them for the alleviation and prevention of disease. It is therefore with peculiar gratitude that physiology brings its tribute of admiration and veneration to the memory of one great in character as in achievement, and great even among the greatest of the benefactors of mankind, Joseph Lister.

Obituary.

Prof. Ira Remsen.

Soon, few chemists will be left who have passed the age limit. Already, during this year, three of my oldest friends, all distinguished chemists, have ceased to be. Hermann Wichelhaus, who was my fellow-student at the Royal College of Chemistry, Oxford Street, under Frankland in 1866; Carl Graebe, who was *privat docent* and worked at a bench close to mine in the old laboratory in Leipzig in 1868; Ira Remsen, the American, who went to Germany when I did, whom I did not meet, however, until after the Johns Hopkins University was established. The first was concerned with Darmstaedter, in 1869, in introducing the soda-melt into the naphthol industry; the second stands for quinone and artificial alizarin; the third for saccharin: all very notable connexions.

The story of Ira Remsen's career has been well told by Dr. B. Harrow in "Eminent Chemists of our Time" (T. Fisher Unwin, 1921). He was of Dutch parentage. The elegance of his name was matched by the elegance of his person: he was always a man of gracious presence and owed much of his success and influence to his attractive personality. Five years' serious study in Germany made him both a real chemist and a modest man—with a sense of proportion not always to be found to-day in the chemist, particularly in his own country. His career before going abroad is of interest, as showing how miserable were the opportunities of students in his youth. His father made him take up medicine and apprenticed him to a medical man, who was teacher of chemistry in the Homeopathic Medical College, New York, whose teaching consisted in giving him a book and telling him to read. A casual experiment which he made (with generally destructive results) to ascertain what was meant by "Nitric Acid acts on Copper" seems to have infused him at this time with a special interest in chemistry.

However, Remsen graduated in 1867, at twenty-one, as doctor of medicine, submitting a thesis on the fatty degeneration of the liver—of which he was profoundly ignorant. He then insisted on going abroad to study the subject for which he had a liking. He first worked, during a year, in Munich with Volhard, then two years in Göttingen with Fittig, taking his Ph.D. in 1870. He spent the next two years at Tübingen as assistant to Fittig. He was, therefore, under the best of influences in Germany.

Remsen found no immediate opening on his return but eventually became professor of physics and chemistry at Williams College—without a laboratory. We are told, that when he preferred a mild request for one, the president's answer was: "You will please keep in mind that this is a college and not a technical school. The students who come here are not to be trained as chemists or geologists or physicists. They are to be taught the great fundamental truths of all sciences. The object aimed at is culture, not practical knowledge." With which immortal discourse the great man dismissed the subject, says Remsen's biographer, as though the view expressed were a mistaken one. I am inclined to think that Remsen, to-day, would perhaps be inclined himself to give a similar answer, though without advocating 'no laboratory.' An I be not mistaken, the advice thus given by the president of Williams fifty years ago is much needed throughout the university world to-day, especially in the U.S.A. culture—knowledge of the great fundamental truths—is what is now most wanted among us: students get it nowhere.

At thirty, Remsen became professor of chemistry at the Johns Hopkins post-graduate university established, in Baltimore, in 1876. Ultimately, he was president of the University. He is to be credited with two great achievements: in 1879, together with Fahlberg, he discovered saccharin; he also started the *American Chemical Journal*, which he carried on until 1914, when it was merged in the *Journal of the American Chemical Society*. Saccharin is now an excisable article in our free-trade country. There are three factories making it. For the year ending Mar. 31, 1926, the total duty collected was £83,118, of which the Customs duty on imported saccharin amounted only to £567. The rates of duty for sugar and saccharin respectively are 11*s*. 8*d*. per cwt. and 3*s*. 9*d*. per ounce. This is approximately as 1 : 550, the ratio of the assumed sweetening powers of sugar and saccharin.

The retention of benzoic acid as a permitted preservative in food is due to a Board appointed by President Roosevelt, in 1909, of which Remsen was chairman. He and other members tested its action upon themselves—and lived through the trials. The public generally here has lived through trials upon itself with far larger amounts of boric acid, which is disallowed—although no *scientific* proof of its harmfulness has yet been given. Maybe, the presence of preservatives in food is entirely undesirable. It should, however, be understood that they have been rejected on grounds other than scientific.

It is to be hoped that a carefully studied life of Remsen may be written, to display to his countrymen the many important lessons which are to be derived from the career of a man possessed by an abundant clarity of spirit, sure in his judgment and rare in his courtesy, gifted with breadth of outlook and sense of proportion and of wide experience. Without being a genius, he was deeply devoted to his subject and well versed in its mysteries. We have yet to learn whether the establishment of the Johns Hopkins University, a unique institution, with which he was so intimately connected, has been justified by results. We may suspect that, as in all other institutions, success in so far as it has been attained, has been the product of leadership. In modern times, killing the slain with the aid of the beginner has been developed to the finest of arts, under the guise of research. We need to take stock and consider, if considered study of what is known be not the better preparation even for the future inquirer and whether the assembly of original workers *en masse* be indeed desirable.

HENRY E. ARMSTRONG.

MR. A. B. DEACON.

THE science of anthropology has suffered a grievous loss by the death of Arthur Bernard Deacon in Malekula, New Hebrides, of heart-failure following black-water fever, on Mar. 12. Mr. Deacon was born of British parents at Nicolaiev, South Russia, on Jan. 21, 1903, and came to England in 1916. He attended the Nottingham High School, where he did remarkably well. He obtained a State Scholarship, an Old Boys' Exhibition, and an Open Scholarship at Trinity College, Cambridge, and obtained firsts in the Natural Science Tripos, Part I, in 1923, the Mediæval and Modern Languages Tripos (Literature and History), with distinction in Russian, in 1924, and the Anthropological Tripos in 1925, and was appointed to the Anthony Wilkin Studentship.

While still a student, Deacon wrote a suggestive paper, "The Kakihan Society of Ceram and New Guinea Initiation Cults" (*Folk-lore*, 36, 1925, p. 332), in which he correlated the ghost-societies of Melanesia with the initiation cults of the Melanesian-speaking peoples in the Mandated Territory of New Guinea on one hand and with the Kakihan of Ceram on the other; the latter is essentially a 'ghost-society' and most completely represents the original cult.

Later in 1925, Deacon went to the New Hebrides. While waiting at Espiritu Santo for a boat to Malekula, he did some useful preliminary work and got into touch with natives from other islands; the following year he did excellent work in Ambrym. In 1926 he landed at South-West Bay, Malekula, on his birthday, and at once got to work, but he found a "general chaos of native life" and an "utterly appalling depopulation." In dispiriting circumstances he gathered all that he could in this district, and later spent three months in north-central Malekula, where he obtained good results, though even there the "death-rate has been ghastly." He gathered a good deal of detailed information about social regulations, relationships, etc., cannibalism, chieftainship, polygyny, songs, games, and also made the surprising discovery of remarkable geometrical designs, of which he collected some sixty examples. These and his other investigations will be published in due course.

The results obtained by Deacon far exceed what might be expected from a first attempt in field-work, and they prove that he had an exceptional aptitude for anthropological investigations. Those of his notes which have reached me show that he was fully alive to the problems concerned, and that, though interested in details, he was continually alert to the conclusions to which they pointed. His death is an irreparable loss not only to science but also to all who came into contact with him. He was a cultured, talented man with a charming modesty and with a sure promise of a brilliant future.

A. C. HADDON.

AN account of the life and work of Dr. Luigi Casale, written by Dr. J. F. Crowley, who has been closely associated with the Italian chemist, appears in the issue of *Chemistry and Industry* for Mar. 11. Casale was born in 1882 at Langosco and was educated at Turin. He became head of the organic chemistry laboratory in the institute of general chemistry in the University of Turin in 1913. In 1915 he became head of the pharmaceutical chemistry laboratory of the University of Naples, where he carried out important investigations for the Italian War Office. Dr. Casale became interested in nitrogen fixation in 1917, and shortly after 1920 commercial plants for the production of synthetic ammonia by his process were in operation. The Casale process has been adopted in many parts of the world: the total capacity of the plants completed or in course of construction using this process amounts to 250,000 tons of ammonia per annum. The total world output of synthetic ammonia in 1925 was 350,000 tons. Dr. Crowley refers to the great personal charm of Dr. Casale, his high qualities as an investigator, and the loss which applied science has sustained by his early death.

WE regret to announce the following deaths:

Mr. G. L. Cathcart, senior fellow of Trinity College, Dublin, who for many years edited Salmon's mathematical works, on Mar. 26.

Prof. D. A. Gilchrist, who recently retired from the chair of agriculture at Armstrong College, Newcastle-on-Tyne, on April 4, aged sixty-seven years.

Prof. C. S. Sargent, of the Arnold Arboretum, near Boston, foreign member of the Linnean Society of London, aged eighty-five years.

Prof. O. Sars, formerly Director of Fisheries Research in Norway, foreign member of the Linnean Society of London, and author of a monograph on the Crustacea of Norway, on April 9, aged eighty-nine years.

News and Views.

The appointment of Mr. H. T. Tizard as successor to Sir Frank Heath as Secretary of the Committee of the Privy Council for Scientific and Industrial Research, which has recently been announced, will be welcomed by many. He is a scientific worker whose work on internal combustion engines has brought him well-earned distinction; he has had considerable experience as an aviator, having been for a long time in command of the test squadron at Martlesham Heath; and it is obvious that he has proved his capacity as an administrator during the years he has been on the headquarters staff of the Department of which he is now to become the administrative head. His appointment is a further challenge to the belief cherished in certain circles that a man who has achieved distinction in a specialised field in science must necessarily become narrow in outlook and less fitted to undertake the duties and responsibilities of administering a department of State than one who has achieved distinction in classical, historical, or literary studies. Those scientific workers who believe that a scientific training and outlook are indispensable qualifications for the task of administration in the modern State will find Mr. Tizard's appointment peculiarly gratifying.

The British patent system has undergone no fundamental change since the introduction, by the Patents Act of 1902, of a tentative step from the French towards the German or American plan, and the present rather illogical compromise has found practically no imitators amongst the industrial countries of the world. The system has now been on its trial for a quarter of a century, and it should be possible to learn, from the experience gained during that period, what further changes would probably be beneficial in stimulating British industry. In these circumstances the British Science Guild has appointed a strong committee to explore the question of possible reform: the chairman is Prof. W. H. Eccles, and the members include, amongst others, Mr. James Whitehead and the Hon. H. Fletcher Moulton, of the Patent Bar; Messrs. H. A. Gill and Dunbar Kilburn, representing the patent agents; Messrs. William Martin and A. F. Ravenshear, both authors of well-known books on the patent system and formerly members of the examining staff of H.M. Patent Office; Sir Richard Gregory, Dr. A. Ree, and Messrs. S. G. Brown and C. C. Paterson. The only criticism suggested by a scrutiny of the list of members is that manufacturers and inventors themselves, particularly those who have succeeded in establishing new manufactures with scanty financial backing, might with advantage be somewhat more largely represented. Actual legislation can scarcely be expected without the inevitable preliminary of a Government committee, but invaluable pioneering work can be done by an expert if unofficial committee like that which has just been set up, and should the latter arrive at positive conclusions, Government action of some kind could scarcely be refused.

A serious drawback to the more general use valve sets for receiving broadcasting is the necessit of having a high-tension dry battery, a low-voltag accumulator, and a medium-tension battery to giv the grid a bias. For several years consumers hav wondered why inventors have not designed apparatu which would give the required voltages from a publi electric supply system. One of the difficulties whic has to be overcome before this can be done is t eliminate the high-frequency ripple which is presen in direct-current supply systems which use dynamo as generators. If we put a telephone in series with megohm and connect the two in series across th supply mains, an almost intolerable scraping nois will be heard, due to the commutator segments of th generators moving past the brushes pressing on them The first thing that has to be done, therefore, is t eliminate this ripple by means of a suitable electri filter. If the supply is alternating current, a rectifie to make the current pulsate always in one directio must be used in addition. The lighting supply als is at a high voltage, and to avoid fire risk the receiving set must be much better insulated than it is usually. The great boon, however, of being able to get rid of the trouble and expense of charging accumulators and maintaining them in good order would counterbalance the extra expense of having a standardised receiving set which could be operated from the lighting mains.

In a paper read to the Institution of Electrical Engineers on April 6, P. R. Coursey and H. Andrewes discussed the apparatus required to operate radio-receiving sets from the electric-lighting mains. Appliances of this kind are generally referred to as 'battery eliminators,' but this name does not seem to be happily chosen. Simple filter circuits were described which effectively eliminate the hum caused in the telephones or loud speaker by the ripple in the supply. It is found in practice that with ordinary lighting pressures a ripple of amplitude equal to 0·2 of a volt is not an appreciable drawback. In one system the ordinary accumulators are used and are charged automatically from the supply mains at a low rate, whenever the radio set is not in use. The authors call this device a 'trickle charger.' The disadvantage of the method is that either the battery is overcharged under normal conditions, or else it may not last sufficiently long should it be required to be in operation for a longer period than usual. In another method, no accumulators are used, the cathodes in the valves being heated by means of an internal heating element which is operated directly from the lighting mains. It will be seen that the problem has been practically solved. What is now wanted is a standardised radio-receiving set actuated from the lighting mains, which can be bought at a reasonable price.

The first national bird sanctuary to be created in Scotland is now in being, and a "Report of the

Committee appointed by Viscount Peel to consider the establishment of Bird Sanctuaries in the Royal Parks of Scotland" (H.M. Stationery Office, price 6d.) indicates the progress which has been made during the first year of the reservation of Duddingston Loch. An interesting appendix to the Report, on "Duddingston Loch and its Bird Life," summarises the three lines along which steps have been taken to increase the attractiveness of the area, which lies within the bounds of greater Edinburgh, for migrating and nesting birds: first, by preventing the actual depletion of the resident bird life which has until now taken place through the destruction of eggs and nests by trespassers; secondly, by adding new cover, which may afford nesting sites during spring and summer for more birds and greater variety of birds, especially of the smaller kinds; and thirdly, by providing shelter and a natural food supply during the autumn and winter, which may induce migrant birds to halt awhile on their southward journey. At the outset of its existence as a sanctuary, Duddingston Loch and its immediate surroundings possessed a bird population consisting of 17 resident and breeding species, 40 regular visitors, and 16 casual or occasional visitors. It is hoped that each of these classes may be added to as the plans of the Committee become effective.

Mr. C. L. Woolley's final report on the season's work at Ur, in the *Times* of April 12, chronicles the premature stoppage of excavation on Feb. 19 owing to lack of funds. This is tantalising, in that the expedition was then working on one of the most promising sites it has yet touched, and had unearthed a treasure which in the number and character of its relics is probably as rich as any that has yet been found in Mesopotamia, and may justly, as the director claims, be compared with that of the tomb of Tut-Ankh-Amen. From the chronological point of view in particular, its importance is marked. At the topmost level were graves dating to about 2600 B.C., as was shown by two seals of members of the household of the daughter of Sargon of Akkad; below were graves similar in character with basketwork coffins or simply a lining of matting, but of earlier date, as shown by the associated objects, and belonging to the period between 3200 and 3100 B.C.; and below these again were series of graves of which the earliest must go back to 3500 B.C. It is these last which have proved of such unexampled richness, the finds including decorated and engraved shell plaques, and a hoard consisting of quantities of copper implements and weapons. Scattered on the ground were a number of carnelian, lapis, and gold beads, the gold binding of a bow, an adze of solid gold, of which the handle was covered with gesso painted red and bound with gold, a silver baldric with a 'vanity case' of gold toilet implements attached, and a marvellous dagger with a hilt of lapis lazuli studded with gold, a blade of burnished gold, and a sheath of gold of which the front is covered with a design in filigree. This is one of the oldest known examples of the goldsmith's art. It seems scarcely credible that an expedition sent out by a national institution which had obtained such important and remarkable archæological and historical evidence as has been brought to light at Ur, should have to cease work through lack of funds just when so noteworthy a result had been achieved.

It is satisfactory to record that many of the finer stone implements recently sold with the Hewlett Collection will be kept together. We are informed by Mr. Alexander Keiller that about a half of the flints from the eastern counties, and by far the greater number of the picks and axes from the South Downs collected by Mr. S. G. Hewlett, have found a home in his Museum at 4 Charles Street, London, W.1. In Mr. Keiller's opinion, an explanation of the low prices which prehistoric implements fetch at public auctions, is that they are put up for sale in boxes of 30 or 40 together in a lot, and so dirty that only the most scrupulous examination before the sale, coupled with a vivid imagination, will enable the prospective buyer to discover the treasures. Consequently their true value is seldom appraised by more than one or two of those who afterwards bid for them. Mr. Keiller informs us that his collections include portions of the Hewlett, Knowles, Crawshay, Kendall, Wilks collections, while one section is confined solely to housing the finds of all descriptions—flint implements, pottery, bone, and so forth—from his and Mrs. Keiller's annual excavations of the neolithic site of Windmill Hill in Wiltshire, together with the surface finds of flint implements from that site and from others nearby. The collections are open to view to any one recommended by a recognised Society.

The British Isles were magnetically surveyed by Rücker and Thorpe in 1884–1888, 205 stations being occupied; and again, in much greater detail (677 stations), in 1889–1892. Then a long interval followed before the next survey, of 183 stations, by G. W. Walker in 1914–1915. In future the Ordnance Survey will undertake magnetic surveys, and it has been decided that the first re-survey shall be made by five annual tours, re-occupying Walker's stations (with a few additions and omissions as may prove necessary), beginning in 1926. When this programme has been completed, the speed of subsequent revisions will be considered. H.M. Stationery Office has just issued "Results of the Magnetic Observations made by the Ordnance Survey in the Channel Islands in 1925 and in Southern England in 1926" (9*d*. net); it gives values of the three magnetic elements for 7 stations in the Channel Islands and 30 in Southern England. The data are corrected to the epoch 1925.5 or 1926.5, using Greenwich or Abinger as base station. The corresponding data from the last previous survey are given for comparison.

The losses caused by mosaic diseases of cultivated plants have of recent years assumed alarming dimensions, and at the present time these virus pests are the most destructive pathogens of potato crops both in Great Britain and America. Every year brings records of some new victims of these diseases, and serious mosaic attacks on the sugar-cane have just been reported from Cuba. The problem in this particular case is complicated by the fact that certain wild grasses are not only themselves susceptible to this form of mosaic disease, but also harbour the insects responsible for transmitting the infection. In the meantime the Smithsonian Institution and the Tropical Plant Research Foundation are co-operating in an attack on the problem, and Prof. Hitchcock is already busy collecting and identifying the grasses likely to be concerned in the propagation of the disease.

The Minister of Public Instruction of the French Republic, having ratified the nomination made by the Council of the Faculty of Medicine of Strasbourg, Prof. George H. F. Nuttall, Quick professor of biology in the University of Cambridge, has been made professor, *honoris causa*, of the University of Strasbourg.

At the meeting of the London Mathematical Society on Thursday, May 12, at 5 P.M., at the Royal Astronomical Society's Rooms, Burlington House, Prof. H. F. Baker, Lowndean professor of astronomy and geometry in the University of Cambridge, will deliver a lecture on "Geometry and Differential Geometry." Members of other scientific societies are invited to be present.

Sir John Russell, Director of the Rothamsted Experimental Station, Major Walter Elliot, Parliamentary Under-Secretary of State for Scotland and chairman of the Research Committee of the Empire Marketing Board, and Dr. J. B. Orr, Director of the Rowett Institute for Research in Animal Nutrition, Aberdeen, are on their way to Palestine to inquire into problems of animal husbandry and dry farming. The delegation will meet delegates from Cyprus, and probably also from Iraq.

A Danish scientific expedition, under the leadership of Prof. C. Olufsen, and supported by the Carlsberg Fund, is now on its way to Senegal to explore the upper region of the valley of the River Niger, the Upper Volta, and the south part of the Sahara, especially Air (Asben or Agadir). The expedition, the main purpose of which will be to collect objects of ethnological interest for the Danish Museums, is to return via Zinder and Kano, through Nigeria, to the Guinea Coast, and thence by sea to Dakar. Prof. Olufsen will be accompanied by two Danish scientific workers, Mr. Oluf Hagerup (botanist) and Mr. Harry Madsen (zoologist).

Dr. F. L. Pyman, professor of technological chemistry in the University and in the College of Technology, Manchester, has been appointed head of the research laboratories of Messrs. Boots Pure Drug Company, Ltd. The firm has decided to extend the scope of the research work carried out at Nottingham, and for this purpose new laboratories are being equipped, whilst the staff of research chemists is to be increased. A primary object of this new development is the prosecution of fundamental research in the domain of chemotherapy, and Prof. Pyman's high qualifications and scientific record are a sufficient guarantee that a high standard will be maintained. His better-known investigations are concerned with the chemistry of the alkaloids and of synthetical compounds closely related to them; recently he has devoted much attention to the glyoxaline group and has effected a brilliant synthesis of one of the most important members of the series, namely, histidine, a structural unit of some protein molecules.

The Council of the Illuminating Engineering Society has unanimously nominated Mr. D. R. Wilson as president for the coming session. Mr. Wilson has been associated with much valuable pioneering work on industrial lighting. The reports of the Chief Inspector of Factories for 1911 and 1912 contained special contributions by him dealing with problems in factory lighting, and in 1913 he took an active part in the formation of the Home Office Departmental Committee on Lighting in Factories and Workshops, of which he became secretary. He has since taken a leading part in bringing the benefits of good lighting before the various joint industrial councils, and he is a member of the Illumination Research Committee working under the Department of Scientific and Industrial Research. The impartial position of Mr. Wilson, as well as the services he has rendered to illuminating engineering, will no doubt ensure this nomination receiving the cordial support of members of the Illuminating Engineering Society.

Applications for grants from the Dixon Fund for assisting scientific investigations must be made before May 15 to the Academic Registrar, University of London, South Kensington, S.W.7. They should be accompanied by the names and addresses of two references.

The tenth Italian Geographical Congress will be held at Milan on Sept. 6-15 this year under the patronage of the King of Italy and the honorary presidency of the Prime Minister. It is being organised by the Italian Touring Club. There will be five sections: (1) Physical and cartographical; (2) historical; (3) political and economic; (4) explanation; (5) education. At the conclusion of the meetings there will be a number of excursions, by rail or road, to various parts of Italy. During the Congress there will be an exhibition of recent Italian maps and photographs.

The Russian Academy of Sciences has started publishing a special series of "Contributions on the Resources of the Yakutsk Republic," embodying the results of various expeditions carried out during recent years. The first volume contains an exhaustive memoir of V. L. Komarov on the flora of Yakutia, including the history of botanical exploration, a complete list of plants, exhaustive bibliography, and several useful maps. The second volume, by E. Stelling, D. A. Smirnov, and N. V. Rose, deals with observations on terrestrial magnetism in Yakutia, where is located the largest known area of anomalous magnetic phenomena; the work includes complete records of numerous magnetic observations in the country since 1893. Other parts already published are on fishes of the Khatanga basin, by L. S. Berg; on the Coccinellid beetles of Yakutia, by F. G. Dobrzhansky; on the hydrology of the eastern Siberian Polar Sea, and so on.

A RECENT issue of the *Bulletin of the American Mathematical Society* gives interesting historical particulars of the Society's development. Founded in 1888 as the New York Mathematical Society, its activities soon assumed a national character, the title 'American' dating from 1894 and the *Transactions* from 1900. The Society's meetings are held at various centres in the country from time to time, a practice that could well be adopted by some of the English learned societies which meet only in London. Ten colloquia connected with the summer meetings of the Society have been held, the lectures given at the more recent ones being available in book form. In 1914 the membership had reached 700 and the Society was recognised as one of the world's great scientific societies. At the end of the difficult War period, the Society, like most similar bodies, was faced with a serious financial crisis due to the great increase in the cost of printing its *Transactions*. The membership has now increased to 1700, and more than thirty sustaining members, comprising some of the great engineering firms and insurance companies of the country, as well as several universities, contribute annually to the support of its activities. In the last direction also there is scope for similar development in Great Britain.

ON several previous occasions we have directed attention to the sets of coloured post-cards issued by the British Museum (Natural History), South Kensington, London, S.W.7, and illustrating British or exotic insects contained in the collections. Four new series illustrating exotic moths (sets E45 to E48) have recently appeared. The 47 examples depicted on the fifteen cards in sets E45, 46, and 48, are selected on account of their rarity, while set E47 illustrates the occurrence of eye-spots in various families of moths. In all cases direct colour photography has been used of actual specimens, and the reproductions portray their coloration and form with remarkable fidelity. Each set consists of five cards, and is obtainable at the Museum, price 1*s*. per set.

WE have received a copy of the Catalogue of the Collections in the Science Museum, South Kensington, Chemistry Section, published for the Board of Education (London: H.M. Stationery Office, 1927). The catalogue, which is illustrated by plates and contains interesting descriptive notes of the exhibits, forms a useful guide to the collection in the Museum. Among the exhibits are a replica of Black's balance, some of the original apparatus used by Graham in experiments on colloids and on gaseous transpiration, Hartley's quartz spectrograph, specimens of synthetic rubber prepared by Sir William Tilden in 1892, several specimens which belonged to Faraday, and reproductions of other notable apparatus. There are also collections of specimens intended to illustrate important branches of chemistry, such as synthetic and natural dyes, alkaloids, vitamins, and laboratory apparatus.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A resident tutor in economics in the University of Bristol—The Registrar (April 30). Part-time gas examiners under the London County Council—The Clerk of the London County Council, The County Hall, Westminster Bridge, S.E.1 (May 9). A qualified dentist and a woman assistant under the Medical Research Council for work in connexion with a special investigation into the causes, progress, and prevention of dental caries in children—The Secretary, Medical Research Council, 15 York Buildings, Adelphi, W.C.2 (May 11). A pathologist and bacteriologist at the Hospital for the Insane, Claremont, Western Australia—The Agent General for Western Australia, Savoy House, 115 Strand, W.C.2 (May 16). A lecturer in physics in the Queen's University of Belfast—The Secretary (May 28).

Our Astronomical Column.

KORDYLEWSKI'S VARIABLE STAR.—This very remarkable variable, the position of which for 1927·0 is R.A. $12^h\ 33^m\ 16^s{\cdot}6$, S. Decl. 17° 7′ 3″, is in the same field as S Corvi, and was first seen by the discoverer, at Cracow Observatory, on Dec. 14, 1925. He was familiar with the field, as he was in the habit of observing S Corvi and noticed the presence of a strange star, the magnitude of which on the B.D. Scale was 9·5 or brighter. There were then two months of cloudy weather, after which he failed to find the stranger. Search on the Harvard plates was at first abortive, but a recent Harvard post-card circular announces that images have been found on seven plates taken between 1895 and 1908. They suggest a period of about 400 days, which is confirmed by the star's recent reappearance. The range of photographic magnitude is from 11·5 to less than 17, and therefore about the same as that of Mira Ceti.

Recent photographs by Herr Pavel at Babelsberg on plates of different types show that its colour index is greater than $1{\cdot}5^m$, which would explain its visual brightness at the time when Kordylewski discovered it. The star was in opposition to the sun at the beginning of April, and is therefore well placed for observation during the next two months. Observations are very desirable in order to determine the character of the light curve. Owing to the large colour-index, the type of plate used should be noted in photographic observations.

CALENDAR REFORM.—Mr. M. B. Cotsworth, known to most computers by his useful calculating tables, is an enthusiast for calendar reform, and has published a pamphlet on the subject under the auspices of the Pan-American Union. He traces the history of the calendar from early times, noting the great advantage that the use of a solar year gave to all nations to whom agricultural operations were important. He seems to be in error in stating that a 'leap-year' was used in ancient Egypt. His suggestions for reform of the calendar are now familiar, namely, 13 months of 4 weeks each, and one day each year (two in leap-year) that stand outside the weekly reckoning. Both suggestions excite considerable opposition, and there appears to be little prospect of general agreement upon them.

Research Items.

HUMAN SKULL FROM KENT'S CAVERN, TORQUAY.—A skull found last year by the owner of Kent's Cavern is described by Sir Arthur Keith in vol. 4, Pt. 4, of the *Transactions of the Torquay Natural History Society*. The skull had evidently been deposited in a fissure in the rock, and although nothing was discovered which would assist in determining its age, two shells found at the same level near by have been identified as Pleistocene, while the condition of the skull fragments is such as is usually found in bones discovered in or under the stalagmite floors of limestone caves in England. The skull on reconstruction by Sir Arthur Keith is clearly that of a female, short and relatively broad, length 175 mm. (estimated), breadth 143 mm., cephalic index 81·7. It is high, the highest point of the vault being 120 mm above the upper margin of the ear. The upper part of the forehead is prominent, projecting in front of the glabella. The face is remarkably short and narrow, the nose short, flat, and snub. All the teeth were healthy and present at the time of death, which took place about the age of twenty-five years. The palate is virtually identical with the half a human palate found embedded in stalagmite at a depth of 20 inches by Mr. Pengelly in 1867. The skull in form is identical with the remarkable rounded high-vaulted skulls of late palæolithic date found at Aveline's Hole, and comparable to the skulls of very similar form found at Solutré in France, which thus suggest a possible place of origin for these palæolithic brachycephals of late palæolithic age in Britain.

AMERICAN-INDIAN MUSIC AND MUSICAL INSTRUMENTS.—In *La Nature* for Mar. 15, Dr. Paul Rivet discusses the music and musical instruments of America, especially of Central and South America. He notes that while collections have been made in the northern half of the continent, little has been done for the rest of America, this being all the more surprising because of the marked effect which, it has been stated, such music has on the Spanish American. The lack of recorded material has been remedied in some degree by the publication in 1925 of a careful study of Peruvian Music by M. and Mme. D'Harcourt (Paris, 1925) which deals with the music of the Incas and its survivals, and comparatively with the indigenous music of other parts of America. Before the conquest, the Indians used wind and percussion instruments only. The different types of each present some peculiarities of distribution not easy to explain. The wooden drum, the *teponaztli* of the Mexicans, for example, is found only in the Antilles basin and the north of South America; the pipe, which is spread over the whole of the north of South America, does not cross the Panama isthmus; while the ocarina occurs only in central and north-west South America. The vertical flute or whistle, or its near relative the flageolet, is found all over America except in the extreme north and south. The Peruvians used only the straight whistle form and not the flageolet, but extended it to eight notes as against the five of the Mexican flageolet. It attained its most highly developed form in the pottery pan-pipes of Nasca, which were sometimes strikingly ornamented with decorative motifs. Among the instruments of America it is possible to determine foreign origin and the provenance of a number, but others present greater difficulty, such as, for example, the musical bow. Such cases may lend support to the theory of an Oceanian origin in part of the American people which M. Rivet has already supported on other grounds.

GLASS FRAGMENTS IN PRESERVED FOODS.—From the fragile nature and extended use of glass containers for foods and beverages, it might be expected that glass fragments will from time to time occur in the material and cause injury to the consumer, and the Ministry of Health therefore instituted an investigation on the subject (Ministry of Health. Reports on Public Health and Medical Subjects, No. 37: A Report on the Occurrence of Glass Fragments in Foods packed in Glass Containers. By George C. Hancock. London. H.M.S.O. 1*s.* net). The records for the past five years of four of the largest London hospitals have been searched, but no cases of injury by glass fragments have been met with. A large number of samples has been examined for the presence of glass. In one series of 156 samples, glass fragments were present in 113 (= 72·4 per cent.); but with few exceptions, the glass is present in finely powdered form ($\frac{1}{50}$ in., $\frac{1}{100}$ in. or $\frac{1}{500}$ in. in size) and as such appears to be quite harmless. The largest fragment found was a splinter measuring $\frac{3}{8}$ in. × $\frac{1}{16}$ in. in pickles. Details are given of the method of examination and identification. The residue, after destruction of the organic matter, is collected and examined microscopically. Glass splinters are transparent and usually present characteristic sharp edges. Under the polarising microscope with crossed nicols, glass fragments are invisible and the field dark, but crystals and siliceous fragments appear bright on the dark background.

NEW OR RARE FISHES.—In *Proc. Acad. Nat. Sci. Philadelphia*, vol. 78, 1926, Messrs. C. F. Silvester and H. W. Fowler describe and figure a single individual belonging to the rare and remarkable family of fishes, the Anomalopidæ, which was found floating on the surface of the sea off the coast of Jamaica in July 1908. The discovery is one of unusual interest, connecting as it does West Indian waters with a small restricted family of fishes thought to be confined to the Indo-Moluccan archipelago and the South Pacific. The specimen is placed as the type species of a new genus, with the name of *Kryptophanaron alfredi*. It possesses the peculiar phosphorescent organs characteristic of the family, and, at will, is able to turn on or off the stream of light. Full generic and specific descriptions are given, as well as a revised synopsis of the genera belonging to the family. In the same volume Henry W. Fowler gives detailed descriptions of fishes from several small collections recently received at the academy from Florida, Brazil, Bolivia, Argentina, and Chile. Though few of the species are new, a number are rare or unusual in collections. This paper is of a technical nature, giving the full morphological details upon which identification is based.

EUPHAUSIACEA AND MYSIDACEA FROM THE WESTERN ATLANTIC.—Prof. W. M. Tattersall has found much interesting material in the collections made by the United States Coast Survey steamer *Bache* in the Western Atlantic from January to March 1914. ("Crustaceans of the Orders Euphausiacea and Mysidacea from the Western Atlantic," No. 2634, *Proc. U.S. Nat. Mus.* vol. 69, art. 8, 1926). This area has hitherto been little explored for these groups, but only one new species was found, *Mysidopsis bigelowi*. Perhaps the most important find is the mysid, *Paralophogaster glaber* Hansen, only known up to this time from the Pacific Ocean near the Dutch East Indies and in the waters off New Zealand. The occurrence of the larvæ of *Thysanopoda* (?) *cornuta* Illig from very deep water, 1100 m.-1800 m., is of special interest. From the stations off Chesapeake Bay, where coastal and oceanic waters mix, three northern or boreal euphausians were obtained, including *Meganyctiphanes norvegica*, but all the other material consists of tropical oceanic species in great abundance. The author divides these oceanic species into three groups which characterise the upper (100 m.), middle (100 m.-200 m.), and deep water regions (below 200 m.) respectively, but as he himself says, he has not taken into account the possible diurnal movement of the species which certainly takes place, at any rate in some of the more neritic forms. There is also another fact which might be considered, and that is the tendency which is apparent in many species to approach the coast when breeding and the consequent presence of larval and immature forms in much shallower water. This might possibly account for the numbers of *Euphausia Krohnii* and *Nematoscelis megalops* near Chesapeake Bay. It is not stated whether they were adult or immature. The large numbers of truly oceanic euphausians is well shown in these records, in which much that is new is brought out as regards the distribution of both common and rare species.

UPPER CRETACEOUS FOSSILS OF TENNESSEE.—A series of unusually well-preserved fossils from the Ripley formation (Upper Cretaceous) has recently been discovered at Coon Creek, a few miles to the north-west of Savannah on the Tennessee River, State of Tennessee. This fauna, mainly molluscan, but including examples of other invertebrates and bones of a mosasaurid, has been subjected to systematic study by Mr. Bruce Wade (U.S. Geol. Survey, Professional Paper 137). The geological relations, with a map, and the biological relations of the fauna, with a table of the distribution and range of the constituent species, are set forth in a clear and succinct introduction. The systematic descriptions follow and treat of 224 genera and 345 species, of which a large proportion are set down as new. There is also a good index. The 72 plates from retouched photographs are of the highest quality and a delight to look at. The artists responsible for them, Mr. W. O. Hazard and Miss F. Wieser, are to be congratulated on their excellent work, which contributes in no small degree to the value of this important monograph.

PALÆONTOLOGICAL RESEARCH IN CRIMEA.—Since 1923 the Russian Academy of Sciences has been conducting excavations in the caves of the Crimea, and already very valuable data have been collected, enabling one to form some conclusions with regard to changes of climate and fauna of the Crimea since the middle palæolithic age. The deepest deposits contain many remains of mammals wholly, or nearly, extinct, such as mammoth, hairy rhinoceros, gigantic elk, cave hyena, urox, wild horses, Saiga antelope, and so on. It is particularly interesting that the last-named animal, which appeared in western Europe only for a relatively short period, was living in the Crimea until the beginning of the last century. The excavations supply also very important evidence as to which of the wild mammals are autochthonous in the Crimea, as, for example, the deer, and which are introduced by man. The investigations will be continued during the next season.

RAINFALL IN AUSTRALIA.—The Bureau of Meteorology of the Commonwealth has published an average annual rainfall map of Australia revised to 1924. Only stations with records covering not less than fifteen years have been used in the compilation, and it has been found practicable to draw isohyets for all the continent except the central and western interior. The map does not materially differ from the rainfall maps of Australia already available, but shows a great deal more detail. Isohyets are drawn for every five inches and the colour tint is changed every ten inches, while the scale of the map is two hundred miles to one and a half inches. This allows the rainfall in the important areas of settlement in temperate Australia to be shown with considerable accuracy.

THE DISTRIBUTION OF ARCTIC ICE.—The Danish Meteorological Office has published its report on "The State of the Ice in the Arctic Seas, 1926." Conditions in nearly all Arctic seas were unusually favourable. In the Barents Sea the distribution was about normal, but in August open water reached almost to Franz Josef Land. Eastern Spitsbergen, however, does not appear to have been free of ice, but the west coast was entirely clear during the summer months. The Kara Sea was congested in the south, but vessels got through by using Matochkin Strait. In the Greenland Sea and Denmark Strait conditions were very favourable, and the east coast of Greenland was relatively easy of access. The coasts of Iceland were open throughout the year. On the Newfoundland Banks the amount of ice was below the normal. Ports on the west coast of Greenland were more accessible than usual, and in Hudson Strait there was less ice than has been noted during the past six years. Bering Sea was open so early as the end of June, and there were long stretches of open water along the coasts of Siberia and Alaska during the summer. This is at least the fourth year in which ice conditions generally have been subnormal and in which no exceptional drift has been reported from any part of Arctic seas.

WATER OF THE DEAD SEA.—The water of the Dead Sea has excited the interest of chemists from early times; Lavoisier, Klapproth, Gay-Lussac, and Gmelin were among the first to analyse it. In the *Comptes-Rendus du Laboratoire Carlsberg*, vol. 16, No. 9, the data obtained from samples collected on an expedition in 1911-1912 are published by R. Koefoed and G. Haugaard, together with a review of former analyses. The late Dr. Koefoed accompanied Dr. Ludwig Brühl's expedition and found evidence of a rise in level of the sea, accompanied by the formation of an upper stratum of water of less density (*ca.* 1·15) than the water below, which now has roughly the same density (*ca.* 1·2) as that collected from the surface between 1778 and 1827. The water samples contain chlorides, bromides, and sulphates of sodium, potassium, magnesium, and calcium, and have a total salt content of between 18 per cent. and 32 per cent. At a short distance below the surface the water was found to be nearly devoid of dissolved oxygen, while sulphuretted hydrogen is present in the oxygen-depleted water. The water contains from 0·3 per cent. to 0·5 per cent. of bromine in the form of bromides.

THE NATURE OF LIGHT.—The issue of *Science* for Mar. 18 contains an address by Prof. E. B. Wilson of Harvard to the physical colloquium of the Jefferson Physical Laboratory on some recent speculations on the nature of light. As a foundation for geometrical optics, Prof. Wilson prefers the adaptation of the principle of least action to Fermat's principle suggested by Cox and Hubbard. According to them, the momentum associated with the light quantum $h\nu$ in a medium in which the speed of light is v is $h\nu/v$ and the element of action is $(h\nu/v)ds$. The least action principle then gives $\delta\int(h\nu/v)ds=0$, that is

$\delta\int n ds = 0$ where n is the refractive index of the medium. Prof. Wilson contrasts the theories of the constitution of light put forward by Thomson in 1903 and 1924, and doubts the possibility of the Faraday tube, which unites two charges, being the tube of the same name which can be left behind when one of the charges moves too fast for it. He is disposed to regard Bateman's new solution of Maxwell's equations as of the greatest importance, and thinks him the most consistent of the contributors to electromagnetic theory at the present time.

Electro-Mechanical Oscillators.—For many years attempts have been made to test telephones by applying to them suitable alternating currents having frequencies within the voice range. A method frequently employed in producing these currents is to utilise the phenomenon known as the 'humming telephone.' It has been known for many years that when a telephone receiver is held in front of its associated transmitter, a humming noise is sometimes heard due to self-generated alternating currents, although there is only a battery in the circuit. This suggested the possibility of obtaining small currents in this way. The humming circuit coupling, however, which is an air column with a diaphragm at each end, was found to be very unstable. This has led to the invention of many kinds of electromechanical oscillators, some of which are described by C. R. Moore in the *Bell Laboratories Record* for March. In these devices, generally called 'buzzers,' a purely mechanical element, usually a magnetic bar, one end of which is free to vibrate, is substituted for the acoustical arrangement of the 'hummer.' Although these instruments are quite satisfactory from the economical point of view, they fail to maintain their proper frequency over long periods. In the new device described by the author, both ends of a rectangular bar are free to vibrate, and since the bar is supported at nodal points, almost complete stability is ensured. The driving mechanism consists of a microphone and magnet connected in series with a battery. The mechanical vibrations of the bar are converted into electrical vibrations by microphones placed near the ends of the bar and on opposite sides of it. A very nearly pure wave form is obtained from this arrangement. and its output is more constant than that of any other microphone generator. The device has not yet been perfected, but the results are said to be most encouraging.

Oxidising and Hæmatogenic Power of Bovine Fœtus.—The name embryonin is given by Prof. Angelo Pugliese to an extract of all the organs and tissues of the fœtus of the ox prepared in such a way that all the active principles retain their powers. The effects produced by the administration of this material to young rats, rabbits, and guinea-pigs have been investigated with the help of various collaborators and are described in the *Rendiconti* of the *Reale Istituto Lombardo di Scienze e Lettere* for 1926. In all cases the animals treated with embryonin eliminate increased quantities of carbon dioxide per hour per kilogram of body weight. Moreover, the formation of red corpuscles and of hæmoglobin is stimulated and regeneration after bleeding accelerated; the stimulating action is more pronounced on the colouring matter than on the erythrocytes.

Rotatory Power and Structure of Sugars.—We have received from the United States Bureau of Standards a copy of Paper 533, in which the various articles on the relation between rotatory power and structure in the sugar group, published from time to time by C. S. Hudson, have been systematically arranged and reprinted. The correlation of the rotatory powers of sugars with their structures was begun in 1909 when Hudson put forward his application of Van't Hoff's hypothesis of optical superposition to the sugars and their derivatives. The investigation has since been extended to lactones, amides, phenylhydrazides, etc., and the paper includes a table of the rotations of more than a hundred pure substances which have been measured during the course of this research. The data which are available will be of value to research workers interested in the use of this method of investigation in stereochemistry.

Ignition of Methane by Spark Discharge.—When a stream of sparks, too weak to cause ignition, is passed through an explosive gas mixture a slow reaction takes place, and H. F. Coward and E. G. Meiter have published in the February issue of the *Journal of the American Chemical Society* the results of experiments of this kind which they have carried out with methane-air mixtures. The amount of combination brought about by one weak spark is far too small for direct measurement, but by passing a large number of equal sparks at short intervals the extent and nature of the reaction could be determined by careful gas analysis. The products contain much carbon monoxide and some hydrogen, even in the presence of excess of oxygen. From the observed volumes of gas which have to be ignited in order to produce general inflammation, it is concluded that the spark acts almost entirely as a source of thermal energy.

Valve Steels.—After discussing the various properties which should be combined in a suitable steel for exhaust valves of aeroplane engines, P. B. Henshaw (*Journal Royal Aeronautical Society*, No. 195, vol. 31, Mar. 1927, p. 187) discusses at some length the properties at high temperatures of various alloy steels. It is of interest that in all the steels which retain their strength well at high temperatures, chromium is an essential constituent. Along with it may be found silicon, cobalt, tungsten, and nickel. The main point of interest in the paper concerns an austenitic nickel-chrome steel containing about 0·45 per cent. carbon, 1·75 per cent. silicon, 12·5 per cent. each of nickel and chromium, and about 2 per cent. of tungsten. Tested in the ordinary way, it has a tensile strength of 24 tons per sq. in. at 800° C. and 12·5 at 950° C., values very much higher than are obtainable from any other steel examined. It does not harden by air cooling from any temperature, but is softer and tougher as the temperature from which it is cooled is raised. It is very resistant to scaling, particularly during long time tests. The expansion which occurs on heating takes place fairly regularly, and no indication of any contraction due to a carbon change is to be noted. The total increase of length is, however, appreciable greater than that found in other valve steels. The best temperature for hot working lies between 1050° and 1100° C., and despite the considerable strength at high temperatures, the forging of the steel is distinctly easier than that of many other alloy steels. It can be drawn into wire cold, but the process is not free from difficulty due to the formation of martensite as a result of the deformation. As with all austenitic steels, machining offers some difficulties, especially sawing and drilling. The cutting angles of the tools should be made more acute and the clearances should be as great as possible. Since from its structure this steel cannot be case-hardened, and since the surfaces do not wear well, protection by a harder steel is often necessary and can be done without undue trouble.

Scientific and Industrial Research.[1]

THE Committee of the Privy Council for Scientific and Industrial Research, in presenting its report to Parliament for the year ending July 31, 1926, gives the customary summary of the year's activities of the National Physical Laboratory, the Geological Survey, the nine boards governing researches in specialised fields, and the State-aided industrial research associations. The report also contains a summary of the principal conclusions reached by the Advisory Council, based upon the effects produced during the last ten years by the work of the Department for which it is responsible, and the principles which it is considered should guide further endeavours which are made to assist Great Britain to regain its position as the leading industrial nation of the world.

To the 'general research' programme of the National Physical Laboratory have been added: investigations into the characteristics of insulating materials when subjected to direct and alternating currents, methods of earthing electrical circuits with the object of eliminating danger from leakage currents at high voltages in high-power electrical work, special investigations on the properties of various resistance materials, the effective resistance of large cables of the three-core type, in connexion with which the installation of new high-tension transformers will be invaluable.

Buckley, Collier, and Brookes have devised a method for using the photo-electric cell for colour matching: the cell has been found to be considerably more accurate than the eye. In the Metallurgical Department, considerable progress has been made in research on the alloys of iron, the work being mainly directed to the production of pure iron, free from oxygen, and the constitution of the various iron alloys. The researches have been made more effective by the production in the Department of refractive vessels of pure magnesia and alumina. Increased attention has been given to the fundamental work of the Laboratory on standards. Verification of a number of standards has been made for the Board of Trade, including two new line standards and ninety-six standard weights. Preliminary work on the proposed use of a wave-length of light as the primary standard of length has been completed. An important change has been made in the graduation of scientific glassware, almost all of which is now graded in terms of the millilitre instead of, as formerly, in cubic centimetres. Progress has been made on the work of the international high-temperature scale. In the Photometry Division, work is in progress with the view of the adoption of a black body as a primary standard of light.

The work done by the Laboratory for the boards and committees of the Department, the fighting services and Government departments, continues to increase, while a large number of specific researches are being undertaken for the various State-aided research associations. The researches on the safe loading of underground cables, undertaken for the British Electrical and Allied Industries Research Association, have shown the possibility of immediate economies in the electrical supply industry valued at £250,000 a year. An investigation on the 'spinning' of aeroplanes has been completed. The main features of the effect are now recognised, so that it has been possible definitely to indicate the characteristics of aeroplane design that are likely to lead to danger from inability to recover from a spin. Wind tunnel experiments on the Cierva 'Autogyro' have been commenced. In the Froude Tank the investigation of the influence of waves on the resistance, propulsion, and pitching of ships has been completed by a second series of model experiments, the results of which throw further light on the causes of loss of speed and the shipping of seas in bad weather. Work on the design of propellers and rudders continues. An interesting piece of work has been commenced on the increase of weight due to water absorption of wooden planking cut from timber treated in different ways.

The work of the Laboratory continues to be hampered by the inadequate accommodation and the difficult conditions under which the work is accomplished. It is hoped that sanction may be given at an early date for the erection of the proposed central block for the physics department; the need of further accommodation in the Electro-Technics Division also remains urgent.

The Geological Survey of Great Britain has continued the work of revising the original maps of British coalfields and industrial areas on the basis of the most recent topographical Ordnance Survey maps on the scale of six inches to one mile. A series of memoirs are being prepared on the sources of underground water in Great Britain. A volume on copper ores has been added to the Special Mineral Reports, which describe the principal metalliferous deposits of Great Britain and its deposits of fireclay, ganister, refractories, and other industrial raw materials of mineral origin. The Survey has also resumed the publication of vertical sections to illustrate the sequence of strata in coalfields. Owing to reductions made in the Government's building programme for the year, no further progress has been made towards the provision of a new building at South Kensington, in spite of the dilapidated and dangerous condition of the Museum of Practical Geology in Jermyn Street.

The work of fuel research has been considerably affected by the difficulties of the coal-mining industry: the development of the physical and chemical survey of the national coal resources in particular has been delayed by the general situation. The most suitable means of carrying into effect the various recommendations of the Royal Commission on the coal industry are under consideration, but it is pointed out that the financial resources of the Department cannot meet the increased expenditure which would be entailed by the full programme of research work outlined by the Commission relative to the winning and marketing of coal, which in any case falls outside the present activities of the fuel research division. Work on high-temperature carbonisation continues. The report on the enrichment of coal gas by the injection of oil into vertical retorts during carbonisation has aroused considerable interest in the gas industry and may have important results. Experiments with various types of retorts in connexion with the problem of low-temperature carbonisation continue. Distinct progress has been made with the work on the production of power alcohol from cellulosic materials by bacteriological processes. The by-product of this research is the production from vegetable material, such as straw, of a binding material for the manufacture of briquettes. It is not mentioned in the report, but this may prove to be of the greatest importance in connexion with the development of the Nigerian coalfields, which produce a friable coal.

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[1] Report of the Committee of the Privy Council for Scientific and Industrial Research for the Year 1925–26. (Cmd. 2782.) Pp. iv+178. (London: H.M. Stationery Office, 1927.) 3s. net.

It is interesting to note that an agreement has been entered into with the interests controlling the Bergius process by which the Department obtains full information as to the work on British coals being carried out either in Germany or in Great Britain, and a voice in directing the investigations. Other investigations include an inquiry into the spontaneous combustion of coal in ships, an investigation into slow combustion in boiler furnaces, and a search for suitable metals for the construction of low-temperature retorts.

The year has been remarkable for the increase in the demands from industry for the investigation of special problems in connexion with the preservation and the storage of food. Much information is being accumulated regarding the way in which water is held by the proteins of the flesh of beef and the effect of cold upon the intimate chemical structure of the muscle substance, but it has not yet been found possible to apply the method of very rapid freezing to masses of beef so large as a quarter, or even a joint. No definite programme of work on fish was undertaken during the year, because it had been found that work on fish preservation at an inland station is too wasteful of time and effort. The report emphasises the need for a small research station at a fishing port, and it is understood that arrangements have already been made in connexion with the Empire Marketing Board to acquire a suitable site. The new laboratory at Covent Garden is doing useful work in connexion with the conditions of produce after transport and storage, and the diagnosis of the various types of wastage and depreciation found. Two inquiries of general interest were undertaken at the request of shipping companies: the first was concerned with the leakage of air from one storage chamber to another, resulting, for example, in the contamination of eggs or butter by food odours; the second was concerned with the best design for refrigerated provision stores on passenger boats and with the method of stowage and the temperature to be used for foodstuffs. A report has been published on gas storage, marking an end of a definite stage in this investigation which covers the results of laboratory experiments and storage trials extending over a period of six years.

Many interesting topics are dealt with in the account of investigations given in the various sections under the co-ordinated research boards, among which may be mentioned: stresses in railway bridges; work at the Royal Naval Cordite Factory under Dr. A. C. Thaysen on the deterioration of fabrics by micro-organisms; the development of apparatus for the absolute measurement of sound intensity; the utility of artichokes as a raw material for the manufacture of alcohol and good quality cellulose; the use of substances derived from low-temperature tars and minor metals in chemotherapy; stone preservation and building research generally; and the deterioration and restoration of museum exhibits. An interesting reference is made to the examination of the fatty substance, apparently a cosmetic, contained in a calcite jar recovered from the tomb of Tut-ankh-amen. The fat, which had been sealed up for 3000 years, was apparently of animal origin; a small quantity of resinous and odoriferous substances had originally been added to it.

While the report gives an encouraging account of the researches being undertaken in the State laboratories under the Department of Scientific and Industrial Research and those under the supervision of the various co-ordinating research boards and in university laboratories, the same note of optimism is not present with regard to the industrial research associations, and very little information is available in the report regarding the research activities of these bodies. The Committee of Council states that it has adhered to the policy of continuing to assist for a second five years those associations which have done good work and show promise of becoming self-supporting when normal conditions are restored. During the year the work of the British Motor-Cycle and Cycle Car Research Association, the British Silk Research Association, and the British Cast Iron Research Association, having reached the end of their initial five-year grant periods, came under review. In each instance diminishing block grants have been made for a further period of five years. The British Leather Manufacturers' Research Association has been given a grant on the £ for £ basis for a period of two years. The Committee did not feel justified in giving further aid to the Scottish Shale Oil Scientific and Industrial Research Association, which had not agreed to the recommendations made for the vigorous prosecution of research on a considerable scale involving a considerable increase of expenditure. Further assistance has been given to the British Motor and Allied Industries Research Association, the British Cutlery Research Association, and the British Refractories Research Association. The appeal to the industry for the necessary contributions for the British Empire Sugar Research Association having been unsuccessful, the Committee has not authorised any further grant assistance being given.

The Advisory Council expresses the view that industry is not as a whole sufficiently alive to the need of scientific research or inclined to give sufficient recognition to the work which is being done by the various co-operative research associations. The electrical industry, for example, not only owes its origin to pure research, but is assisted even now more than any other industry by researches carried out in universities and in Government establishments. The work carried out under the direction of the British Electrical and Allied Industries Research Association is of sufficient value to the electrical industry to call for a far greater effort on the part of the supply undertakings to maintain the Association on an adequate financial basis. Further direct support from the taxpayer after the present grant period, which ends in September 1930, cannot be looked for. "We recognise," say the Advisory Council, "the especial difficulties of the time; but nevertheless we must emphatically record our opinion, which we feel assured is shared by all progressive sections of British industry, that essential though a steady scientific policy always is, its importance increases in times of adversity. When we reflect how trivial in relation to the value of the total output of an industry is the expenditure needed to produce by co-operative research results of direct industrial importance, we cannot believe that private enterprise will lack the courage and foresight to maintain on an adequate basis these associations which have already shown their actual and potential value."

During the year under review recommendations have been made by the Advisory Council on the programme for research for 1926–27, for which estimates have been drawn up amounting to £442,877, as compared with £380,263 for 1925–26 and £328,281 for 1924–25, or a slightly greater percentage increase for the current year than for last year. The Empire Marketing Board has promised a grant-in-aid of £25,000 for capital expenditure and £5000 as a first annual grant for current expenses of research for the extension of the work of the Food Investigation Board.

Intensification of the Latent (or Developable) Image.

It was shown recently by Wightman, Trivelli, and Sheppard (of the Research Laboratory of the Eastman Kodak Company) that when single-layer plates were given a very short exposure to light and then treated with a very dilute solution of hydrogen peroxide, that the resulting developability was greater than the sum of the two separate effects. It was suggested that a part of the light-exposure effect was undevelopable, and that the peroxide, besides producing its own developable image, carried over the undevelopable part of the other into the developable condition. This is the phenomenon that is called the "intensification of the latent image."

Messrs. Wightman and Quirk (*Jour. Franklin Institute*, Feb. 1927) have extended this work, using ordinary plates and films. Their method is to give a graduated exposure and to divide the plate into three strips—(1) developed straight away, (2) developed after soaking in a very dilute (0·004 to 0·016 per cent.) solution of hydrogen peroxide, and (3) exactly like (2), but using plain water. The concentration of the peroxide and the time of treatment were varied, and silver nitrate was used instead of the peroxide. They find that hydrogen peroxide and silver nitrate, and perhaps some other noble metal salts, acting on a photographic plate after exposure and before development, increase the developability of the light-exposed portion above its normal developability and in a greater proportion than the unexposed part. The effect is approximately equivalent in degree to that produced by a brief flash exposure of the plate to light before or after the principal exposure. Other circumstances being equal, the effect is smaller on plates of medium speed, and not detectable at all on 'process' (slow) plates or plates that have been desensitised by chromic acid, unless the concentration of the hydrogen peroxide or the time of treatment is considerably increased. By this method it is possible to detect one part of hydrogen peroxide in ten million parts of water to within 20 or 30 per cent. It is considered that the process is not suitable for general photographic work because it needs too much care in its application.

University and Educational Intelligence.

London.—The following courses of free public lectures are announced:—

At University College, at 4.30, on May 3, 4, and 6, "Sensation and the Sensory Pathway," by Prof. J. S. B. Stopford; at King's College, at 5, on May 3, 10, 17, and 24, "Autonomic Nervous System," by Prof. R. J. S. McDowall. At the Imperial College of Science—Royal School of Mines, at 5.30, on May 10, 17, and 24, "Problems of the Respiration of Plants," by Dr. F. F. Blackman. No tickets will be required.

The Rev. L. Van Vestraut, who has for several years been chief assistant in the Testing Department at Faraday House Electrical Engineering College, has been appointed Registrar. Mr. Vestraut is an old student of the College, and was head student of his year. Mr. F. A. Bell has been appointed Secretary of the College.

The New Education Fellowship will hold its fourth international conference at Locarno on Aug. 3-15 next. The general theme is to be the true meaning of freedom in education; Prof. Pierre Bovet of Geneva will be president. The freedom desired is that which comes from inner control, not external restraint, and the conference will seek to discover the basic principles underlying the many novel systems such as the methods called Winnetka, Project, Mackinder, Decroly, Montessori, Dalton, and Howard. Secondary schools, the psychological freedom of the teacher, and local geology are also included in the programme. Several well-known names are on the list of expected speakers. The Fellowship now has associated magazines in six different countries. For England, inquiries should be directed to the secretaries, New Education Fellowship, 11 Tavistock Square, London, W.C.1.

The Carnegie Trust for the Universities of Scotland has completed a quarter of a century's beneficent labour on behalf of Scottish education. Its activities have followed three lines: grants to the universities and extra-mural institutions, endowment of research, and assistance to students. The first are distributed in quinquennial periods, and for the years 1925–30, the twenty-fifth annual report states, there have been allocated for libraries £24,225, for buildings and permanent equipment £196,500, and for the endowment of teaching and other general purposes £10,500. Research endowments for 1925-26 claimed £17,130, and 4711 students received assistance in the payment of class fees to the extent of £57,212. Apart from the encouragement given to the acquirement of knowledge in the class-room and laboratory, the Carnegie Trust most influences science through its research endowments, a very small minority of which are devoted to history and modern languages and literature. A result is apparent in the long list of more than forty contributions to scientific knowledge which have been published during the course of the year by fellows, scholars, and grantees. Three years ago a scheme of 'teaching fellowships' was instituted, which allowed the annual award of grants to university lecturers and assistants, on condition that not less than one-half of their time was devoted to research. This scheme seems to have borne excellent results, and is to be continued in its present form for another trial year, but one of the referees directs attention to the danger that an excessive amount of teaching may be exacted from the recipient of the grant.

In the report for 1926 of the Association of Women Science Teachers, Miss R. Stern has an interesting and valuable paper on the teaching of chemistry in the middle school. She urges that, in the practical work, each experiment should be of such a nature that it brings about a definite result, and that each group of experiments should lead to a definite conclusion. Whenever possible these experiments should be quantitative and require the setting up of apparatus which is not too difficult for the beginner, and they should be of such a nature that faulty manipulation leads to failure. At the beginning of a chemistry course an ordinary text-book is not advisable, as the results of the experiments are given, and this may prevent the class from being conscientious or even truthful. Miss Stern then describes in detail two courses which she has successfully employed. The basis of the first was the preparation of all substances used from materials met with in common life, *e.g.* sand, lime, slate, bricks, etc. Alkalis were prepared by burning beetroot and lixiviating the residue, and altogether the course appears to be a very attractive one. The second scheme is historical, and the author says that she has found this to be more satisfactory in practice than the first, since the historical development of a science is the natural development and is, above all things, a building up from the foundations. It enables the class to realise how discoveries have been made, and teaches them clearly that one wrong step may lead to hopeless confusion. Teachers will find Miss Stern's detailed syllabus of the historical course extremely suggestive and useful; it has evidently been carefully thought out and patiently tested in the school.

Calendar of Discovery and Invention.

April 25, 1839.—Many objections were raised against building ships of iron, but the two real difficulties arose through the disturbance of the compass and the fouling of the hulls. Airy did more than any one to solve the compass problem, but in his autobiography is the entry, "I had in this year (1839) a great deal of troublesome and on the whole unpleasant correspondence with the Admiralty about the correction of the compass in iron ships. I naturally expected some acknowledgment of an important service rendered to Navigation: but the Admiralty peremptorily refused it. . . . The general success of the undertaking soon became notorious, and (as I understand) led immediately to extensive building of iron ships." The vessels Airy used in his experiments were the *Rainbow* and *Ironsides*, and his results were published in a paper to the Royal Society on April 25, 1839.

April 25, 1848.—So far back as 1746 the Government offered a reward of £20,000 for the discovery of a passage by sea between the Atlantic and Pacific north of 52° N., and many explorers sought for the route. Among these was the heroic Franklin. He left England with the *Erebus* and *Terror* in 1845 with 129 men, but none survived. In 1859 relics of the expedition were discovered, and among them this entry, "April 25, 1848: the ships were deserted on April 22nd, having been in the ice since September 12th, 1846. Sir John Franklin died June 11th, 1847, and the total loss to this date has been nine officers and fifteen men. The rest (105 in number) landed here and start to-morrow for the Great Fish River."

April 27, 1857.—The earliest photographs of stars were obtained by Whipple at Cambridge, Mass., in 1850, but double-star photography was inaugurated by G. P. Bond, who on April 27, 1857, with an exposure of eight seconds, obtained an impression of Mizar, the middle star in the handle of the Plough.

April 27, 1888.—In a lecture at the Royal Institution on this day, Wimshurst described his famous influence machine. Of this machine it was said it "completely revolutionised the science of static electricity, for there had never been before its introduction a machine for the production of static charges which was not the subservient slave of the hygrometric condition of the atmosphere." Wimshurst constructed more than ninety such machines.

April 27, 1893.—Thirty-four years ago, Rudolph Diesel explained at Augsburg his ideas on the famous heat engine now bearing his name. The Diesel engine was the result of theoretical inquiries which he published under the title, "The Theory and Construction of a Rational Heat Motor."

April 29, 1820.—The founder of the rubber industry in England, Thomas Hancock, took out his first patent on April 29, 1820, for "an improvement on the application of a certain material to certain articles of dress and other articles that the same may be rendered more elastic." It was, however, not until twenty-three years later, on Nov. 21, 1843, that he patented 'vulcanised' rubber, the term 'vulcanisation' being suggested by his partner Brockedon, Vulcan, of mythology, being considered representative of the sulphur and heat required by the process.

April 30, 1799.—A century ago the most important chemical factory in the world was that of Charles Tennant and Co. at St. Rollox, Glasgow. In 1788, Tennant had discovered a method of controlling chlorine by the admixture of lime, and on April 30, 1799, he patented his method of producing chloride of lime or bleaching powder, a substance for which at first he obtained £140 a ton. E. C. S.

Societies and Academies.

LONDON.

Linnean Society, Mar. 17.—E. M. Marsden-Jones and W. B. Turrill: An improved herbarium method for geneticists, ecologists, and taxonomists. The method has been used at Kew for some years, and, with minor modifications, is capable of very wide application. The process consists in the sticking down of the specimens in the living condition. The best results have been obtained with paste, not with gum or glue, 'Gloy' being the best so far tested. A sheet of paper or card is brushed over with a thin layer of the paste, and the specimens placed on this. They are dabbed down and the sheet is placed in a press and considerable pressure applied. It is advisable to look at the preparations within a few hours, and remove any excess paste. After a few days the specimens are dried; they retain their shape, and sometimes their colour, indefinitely. With some plants, ironing through blotting-paper with a hot iron gives excellent results.—Miss F. Haworth: Lichen dyes. *Parmelia saxatilis* (gathered preferably after a wet day) and *P. omphalodes* are used in the preparation of Harris tweed, and give a characteristic smell to the cloth. Three methods of dyeing are used: (1) Boiling the lichen and wool together; (2) soaking in ammonia for a week; (3) boiling with ammonia for about two hours until mucilaginous, folding dye and cloth alternately and covering with rain water with a little alum, boiling for twenty minutes, and then washing the cloth in cold water. Generally the best results are obtained where numerous soredia are present. Rock lichens give the best dyes, those species with a large flat thallus rarely producing a permanent dye, though *Peltigera canina* gives a yellow colour with cotton.—F. E. Fritch: Heath-association on Hindhead Common. The relative grouping of the different species varies considerably with the time since the last fire, with the aspect, and with soil features. The character of the vegetation shortly after a fire depends upon the size of the growth that was burned, but ultimately Calluna becomes completely dominant and more or less completely hides the codominant, but largely prostrate, *Ulex nanus*. On slopes facing south *Erica cinerea* may become a temporary dominant for some years. Fires cause little ultimate change. Plants like Pteridium and Molinia may exhibit a limited increase of area in the first year after a fire, but do not advance after the vegetation has closed up.

Geological Society, Mar. 23.—E. S. Cobbold: The stratigraphy and geological structure of the Cambrian area of Comley (Shropshire). The exact positions of the excavations made by the author since 1906 are recorded, and the stratigraphy and tectonics as revealed by them and by the surface-features described. The folding and faulting of the Cambrian fall naturally into four groups: (1) post-Mesonacidian and pre-Paradoxidean, general direction unknown; (2) post-Paradoxidean and pre-Caradocian, general direction north-north-west to south-south-east; (3) post-Caradocian and pre-Silurian, general direction north-east to south-west, all the result of compressive forces; and (4) post-Silurian, tensional stresses responsible for the Church Stretton Fault. The facts detailed indicate seven diastrophic phases of various intensities. Special attention is given to the complicated Dairy Hill area, where recent work has fully substantiated the inference previously drawn from the Comley breccia-bed, that a peak or promontory of Lower Cambrian sandstone remained above water during the accumulations of some 300 feet or more of strata of the Paradoxidesgroomi zone.

Edinburgh.

Royal Society, Mar. 28.—**W. Peddie**: Magnetism and temperature in crystals. In earlier papers the development of expressions for the mutual actions of the magnetic molecules, which Weber postulated, were given, subject to the condition that temperature motions of the molecules were neglected. These are now taken into account. An equation of thermomagnetic state is deduced, and subject to the choice of a unit of energy variable with the direction of magnetisation in the crystal, it may be put into a form similar to the thermomechanical equation of state of Van der Waals. Like that equation, it may be put into a form which is the same for any crystal, magnetised in any direction, when the magnetic field, the magnetic intensity, and the temperature are expressed as multiples of the corresponding 'critical' quantities.—**Miss W. M. Smith**: The after-images of coloured light. With stimulation by red, green, and blue lights, no observable fundamental difference was noted in the case of the two latter, possibly because the blue light contained a considerable admixture of green. The succession of colours seen in the after-images can be represented as originating in three independent colour sensations, red, green, and blue respectively. These can be regarded as varying with time in accordance with a simple harmonic law involving logarithmically decaying amplitudes.—**H. H. Read**: The igneous and metamorphic history of Cromar, Deeside, Aberdeenshire. The three phases of igneous activity of this region are (1) the geosynclinal phase, with the intrusion of gabbro sills of pre-metamorphism age; (2) the movement phase, consisting of the injection of acid igneous material during the later stages of the movement-period; and (3) the post-movement phase, exemplified by the intrusion of cross-cutting granites entirely later than the crystal movements. The chief rock of the movement phase is oligoclase-biotite-gneiss considered to result from the union of acid soda-rich injected material with sedimentary pelitic schists. Injection of similar magnetic material into hornblende-schists resulted in the formation of pseudo-dioritic rocks. Post-consolidation phenomena of this injection are due to the action of alkaline solutions producing myrmekite, shimmer aggregates, etc.—**A. Calder**: Rôle of interbreeding in the development of the Clydesdale breed of horses. Using Sewall Wright's coefficient of inbreeding, it is found that during the early history of the breed very little inbreeding has been practised. A method is outlined by which a measure can be obtained of the contribution of any particular sire to the average percentage of inbreeding for the breed, the degree of concentration of his blood in animals inbred to him, and the rate at which his blood is diffused through the breed. The homozygosity of the Clydesdale breed, relative to the condition existing in the foundation stock, has been increased by 6·25 per cent. by inbreeding alone.—**Y. Tamura**: The effects of implantation upon ovarian grafts in the male mouse. Implantation of ovary on to the surface of the kidney of the male demonstrated that in the majority of cases the graft survives and retains the typical ovarian structure. If the germinal epithelium is unimpaired, proliferation occurs and continues until the graft has attained the stage at which it was at the time of operation. The original follicles undergo degeneration.

Manchester.

Literary and Philosophical Society, Mar. 8.—**E. Butterworth**: A new method of electro-conductivity titration. A continuous reading method of conductivity titration employing thermionic valves is described. The apparatus comprises, in its simplest form, two valves, one arranged as an audio-frequency oscillator giving approximately a pure wave form, the other arranged as a rectifier. The titration cell is included in the oscillator circuit in such a manner as to give a sensibly constant peak value of alternating current with appreciable variation of resistance of the cell. The voltage across the cell is then measured by means of the rectifier after the manner of the Moullin voltmeter. The amount of standard substance added is plotted against the anode current of the rectifier. 'Voltage' effects at the electrodes of the cell are excluded. The main advantages of the method lie in the speed and ease of working; the sensitivity can be readily varied within wide limits.

Sheffield.

Society of Glass Technology (Birmingham meeting), Mar. 16.—**Th. Teisen**: Some further developments in recuperative glass furnaces. A new design of recuperator was described in which there is an increase in efficiency: (1) the greater heating surface ensures a higher temperature of the secondary air; (2) the reduction in space results in smaller radiation and convection losses. With the development of the recuperative furnace there has been a demand for large units. When built on the 2-recuperator principle the design outlined has certain drawbacks, to overcome which a new design has been developed on the 'tetra' recuperative principle. This design has four recuperators instead of two, arranged symmetrically in each corner of the base. A simple application of a patent system of oil firing was described. Furnaces working on this system can be fired either with oil alone or with coal or producer gas in the ordinary way, combined with oil as auxiliary fuel.—**Violet Dimbleby, S. English, W. E. S. Turner**, and **F. Winks**: The properties of some soda-lead oxide glasses. Successive replacement of soda by lead oxide gives glasses with progressively decreasing annealing temperature and thermal expansion. The action of boiling water on the glasses has been investigated and the percentage loss in weight determined; lead oxide glasses are better than those containing lime, while those containing barium oxide are the worst of the series. An important new set of factors has been determined by which the thermal expansion of lead oxide and barium oxide glasses can be calculated. The factors originally proposed by Winkelmann and Schott in 1895 need revision, and the following are the new values: SiO_2, 0·15; ZnO, 0·21; Al_2O_3, 0·52; ZrO_2, 0·69; MgO, 1·35; PbO, 3·18; CaO, 4·89; BaO, 5·2; Na_2O, 12·69; K_2O, 11·7.

Paris.

Academy of Sciences, Mar. 14.—The president announced the death of Daniel Berthelot, member of the Academy.—**Pierre Termier**: That the crystallophyllian series of the Vanoise and of Mont-Pourri (Savoy Alps) is Permian or Carboniferous. In 1861, Lachat suggested that the felspar and chlorite rocks of Modane were metamorphosised coal measures, but the view was not accepted. As the result of recent observations, the author considers it definitely proved that the metamorphic strata of Vanoise, Becca-Motta, Aiguille-du-Midi, and Mont-Pourri are of the Permian or Carboniferous age.—**Gabriel Bertrand** and **J. Perietzeanu**: The presence of sodium in plants. It is pointed out that indirect methods for determining sodium in the presence of preponderating proportions of potassium are unsatisfactory, and for this reason a direct method has been used, the precipitation of the triple acetate of uranyl, magnesium, and sodium. By this reaction quantities of sodium between 0·25 mgm. and 2·5 mgm. can be determined, even in the presence of relatively large quantities of potassium. All the plants examined, thirty-five in number, contained sodium in amounts varying from 0·0017 per cent. to 3·507 per cent. of the dry material.—A. Th. **Schloesing** and Désiré **Leroux**: The influence of drying and warming soils on the proportion of phosphoric acid soluble in water. Confirmation and extension of the work of Lebediantzeff on the same subject.—E. **Mathias**: Contribution to the study of fulminating material (lightning). Is it hot or cold?—E. **Bataillon**: The origin of the amphiaster of segmentation in the parthenogenesis of the batrachians, and the problem of regulation.—Bertrand **Gambier**: Surfaces having a ds^2 of Liouville and their closed geodesics.—Georges **Bouligand**: The principle of the positive singularities of Picard.—Paul **Lévy**: The iteration of functions and the idea of regular growth.—D. V. **Jonesco**: A class of functional equations.—Huguenard, A. **Magnan**, and A. **Planiol**: A monograph for the measurement of rapidly varying pressures and an indicator for the study of high-velocity thermal machines.—Ernest **Esclangon**: The stability of projectiles in their movement round their centre of gravity.—V. **Nechville**: Star streams and the solar apex.—Raymond **Chevallier**: A new ferromagnetic ferric oxide. A study of the magnetic properties of ferric oxides produced by the action of hydrogen peroxide and varying quantities of caustic soda on ferrous sulphate solutions. The effects of varying temperatures were also studied.—Henri **Gutton** and Jean **Clément**: The propagation of electromagnetic waves round the earth.—Jean **Cabannes**: The distribution of energy on thermic elastic waves in the midst of a fluid and the diffusion of light by liquids.—Albert **Pérard**: New study of some radiations of mercury, krypton, and xenon from the point of view of their meteorological applications. The results of a detailed study of the following lines are given: Mercury, 435·8, 491·6, 546·1, 577·0, and 579·1; krypton, 557·0, 587·1; xenon, 462·4, 467·1, 473·4.—Emile **Rousseau**: A special action of the radiations of the mercury arc.—Pierre **Brun**: The surface tensions of water-alcohol mixtures. Diagrams are given embodying the experimental results for the surface tensions of water—ethyl alcohol—propyl alcohol and water—ethyl alcohol—isoamyl alcohol mixtures.—G. **Denigès**: The preparation and composition of crystallised blue complex compounds of phosphorus and molybdic acid and of arsenic and molybdic acid.—N. **Maxim**: The action of organo-magnesium compounds on the N-tetrethylphthalimides.—P. **Idrac** and R. **Bureau**: Experiments on the propagation of radiotelegraphic waves at high altitudes.—L. **Eblé** and J. **Itié**: The values of the magnetic elements at the Station of Val-Joyeux (Seine-et-Oise) on Jan. 1, 1927.—M. and Mme. A. **Chauchard**: Researches on the cerebral localisations in fishes.—Philippe **Fabre**: Neuro-muscular stimulation by progressive currents in man.—J. **Risler** and **Foveau de Courmelles**: The radiant shock.—Charles **Pérez**: The postlarval evolution of the pleopods in Galathea.—A. **Paillot**: Experimental *gattine* (silkworm disease) in silk worms.—René **Fabre** and Henri **Simonnet**: Contribution to the study of hæmolysis by the photosensitising action of hæmatoporphyrin.

Geneva.

Physical and Natural History Society, Feb. 17.—Paul **Langevin**: The equilibrium between matter and radiation. The author gives expressions for the number of light quanta the energy of which is comprised between given limits, both as in classical statistics and according to the more recent statistical theories of Bose-Einstein and of Pauli. At high temperatures all the formulæ approach the same expression, which, completed by considerations borrowed from the theory of general relativity, defines the conditions of the genesis of electrons and protons in the interior of the giant stars.—Th. **Posternak**: A new reaction of pyruvic acid. The liquid to be examined is diluted with its own volume of concentrated hydrochloric acid. Some crystals of phloroglucinol are added and the whole maintained at the boiling-point for three or four minutes. If the colour (or precipitate, according to the quantity of pyruvic acid present) turns green after neutralisation with sodium carbonate, the reaction is positive.—P. **Dive**: The impossibility of an ellipsoidal stratification of the planets. The author establishes by calculation the impossibility of conceiving the planets as constituted of ellipsoidal layers, if it is admitted that gravity is normal to surfaces of equal density.—Rolin **Wavre**: The stratification of a heterogeneous fluid mass in rotation. The author demonstrates the three following propositions: (1) Surfaces of equal density tend towards the ellipsoidal form as the centre is approached, (2) if the surfaces were homothetic they will be ellipsoidal, (3) and since, according to Dive, ellipsoidal stratification is impossible, a stratification in homothetic surfaces of a heterogeneous fluid is impossible.—E. **Guyénot** and O. **Schotté**: Graft of a regenerated member and induced differentiation. A regenerated member removed from the foot of 45 days' growth and showing first indications of digits, was transferred to the back of the tail of the same Triton. The subsequent development gave a tail. This regenerated portion transplanted with a section of tissue from the base of the foot on to the tail, however, continued to develop in the form of a foot. Hence it is the base which gives the morphogenetic impulse to the regenerating tissue.—E. **Pittard**: The cranial capacity of the Boschiman Hottentots. Measurements made on 101 skulls lent to the author by the Cape Town Museum have given different averages from those of Broca, namely, masculine skulls 1395·3 c.c. (Broca 1317); feminine skulls 1268 c.c. (Broca 1253).

Rome.

Royal National Academy of the Lincei, Jan. 16.—V. **Volterra**: Laws of biological fluctuations.—O. M. **Corbino**: The Volta effect and the mechanism of the voltaic pile. The Volta effect is considered, and its bearings on the actions of the ionised gas cell, the mechanical cell, and the electrolytic cell are discussed.—O. M. **Corbino**: The electronic theory of the voltaic cell. Since the Volta effect exists in a vacuum and therefore independently of chemical action, the metallic couple, such as zinc-copper, constitutes a natural means for producing an electrostatic field, even in a space of large dimensions. Like a permanent magnet, such a couple creates round itself a magnetic field. The energy of this field is of purely physical origin and is derived from the varying energy of linking of the conduction electrons to the different metals. In the ionisation cell obtained by immersing a metallic couple in an ionised gas, the electrostatic field due to the Volta effect produces a permanent current without furnishing energy, which is supplied from outside. In the hydro-electric cell of the Daniell type the Volta effect is more important; the energy is produced by virtue of the formation of neutral copper and the destruction of neutral zinc, the greater part of the e.m.f. being formed at the contact between the two metals.—L. **Cambi** and Ada **Clerici**: Ferroso-ferric cyanides. Atomic groupings of the form $[Fe(CN)_5X]$ are able to exert chromogenic functions analogous to those of the group [Fe(CN)$_6$]; that is, the groups contained in the ferrous-ferric cyanides may preserve the co-ordinative distribution of the complex ions of the alkaline salts from which they are derived. The presence alone of ferrous and ferric ions is not sufficient for the formation of blue cyanides.—E. Bompiani: Analytical and geometrical investigations on Laplace's equation.—M. Picone: Metaharmonic functions.—F. Tricomi: Limitations of the solutions of certain equations with partial derivatives.—E. P. Lane: Quadrics having for generatrices the tangents asymptotic to a point of a surface.—N. Spampinato: The problem of complex multiplication for any pure body of Abelian functions.—G. Vranceanu: Geodetic stability.—U. Barbieri: Determination of astronomical latitude carried out at Andrate in August 1926. The geodetic and astronomical latitudes of Andrate are respectively 45° 31′ 38·9″ and 45° 31′ 9·8″; and since those of Mondovì were found to be 44° 23′ 24·3″ and 44° 23′ 42·48″, the geodetic and astronomical amplitudes between the two points are 1° 8′ 14·6″ and 1° 7′ 27·3″ respectively.—N. Siracusano: A noteworthy deduction from Bohr's theory. On the assumption that the only atomic model is that of Bohr, it is shown that the natural chemical elements cannot number 138.—L. Mazza: Products formed during the action of lead accumulators (ii). X-ray photographic results show that the paste of the positive plates of lead accumulators consists almost solely of lead peroxide in a normally-charged or greatly overcharged cell and of mixtures of the peroxide and sulphate in cells either partially or completely discharged.—A. Bartorelli: A demonstration of the interdependence between Curie's and Haüy's laws. Objections are raised to Viola's proof (1918) that it is possible to pass from Curie's law to that of Haüy.—U. Panichi: Crystal lattices. Molecular space and atomic number. With the halides of the alkali metals the molecular space increases with the molecular number. For analogous compounds having the same molecular number, the molecular space increases as the ratio of the atomic number of the metal to that of the non-metal diminishes. When this ratio is constant or almost so for non-analogous compounds, that is, those having non-isovalent metals, the molecular space diminishes as the valency increases.—C. Jucci: Maternal and paternal heredity in the capacity for larval development of the reciprocal crosses between two races of silkworms. The results of crossing white with mottled silkworms show that these two characters have a definite value or hereditary power which does not change when the sense of the crossing is inverted. The influence of the factor is immediate when its incidence is maternal but slow when it is supplied by the paternal parent.

Official Publications Received.

British.

Home Office. Judicial Statistics, England and Wales, 1925. Criminal Statistics. Statistics relating to Criminal Proceedings, Police, Coroners, Prisons and Criminal Lunatics for the Year 1925. (Cmd. 2811.) Pp. iv+122. (London: H.M. Stationery Office.) 4s. net.

Journal of the Chemical Society: containing Papers communicated to the Society. March. Pp. viii+iii+529-700. (London: Gurney and Jackson.)

University College of Wales, Aberystwyth. Welsh Plant Breeding Station. The Animal Complex and the Pasture Complex. (Series H, No. 5.) Pp. 54. (Aberystwyth.) 3s. 6d.

University College of Wales, Aberystwyth. Agricultural Department. Advisory Bulletin, No. 2: The Nutritive Value of Grasses, as Pasture, Hay and Aftermath, as shown by their Chemical Composition. By T. W. Fagan. Pp. 23. (Aberystwyth.)

Memoirs of the Geological Survey of India. Palaeontologia Indica. New Series, Vol. 9, Memoir No. 2. Revision of the Jurassic Cephalopod Fauna of Kachh (Cutch). By L. F. Spath. Pp. iii+84+7 plates. (Calcutta: Government of India Central Publication Branch.) 4.12 rupees; 8s.

County Library Conference, November 18th and 19th, 1926, held in the First Avenue Hotel, High Holborn, London, W.C. Report of the Proceedings. Pp. 121. (Dunfermline: Carnegie United Kingdom Trust.)

Some Impressions of the Public Library System of the United States of America. Pp. 90. (Dunfermline: Carnegie United Kingdom Trust.)

Union of South Africa: Department of Agriculture. 11th and 12th Reports of the Director of Veterinary Education and Research. Part 2, January 1927. Pp. iii+819-1361+9 plates. (Pretoria: Government Printing and Stationery Office.) 10s.

The Wellcome Historical Medical Museum, 54A Wigmore Street, London. Pp. 118. (London: The Wellcome Foundation, Ltd.)

Lister Centenary Exhibition at the Wellcome Historical Medical Museum. Handbook, 1927. Pp. 216. (London: The Wellcome Foundation, Ltd.)

Transactions of the Optical Society. Vol. 28, No. 2. Pp. ii+45-116. (London: Optical Society, Imperial College of Science.)

Board of Education. Second Report of the Standing Joint Committee representative of Local Education Authorities and Associations of Teachers on Scales of Salaries for Teachers in Technical and Art Schools in which the Local Educational Authorities accept Responsibility for the Salary Scales. England and Wales, February 1927. Pp. 30. (London: H.M. Stationery Office.) 3d. net.

The Scientific Proceedings of the Royal Dublin Society. Vol. 18 (N.S.), No. 32: The Correlation of Nutritive Value with Dry Matter Content of Pastures. By E. J. Sheehy. Pp. 389-398. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 1s.

Imperial Institute. Annual Report, 1926, by the Director, Lt.-Gen. Sir William Furse, to the Board of Governors. Pp. iii+46. (London.)

Tanganyika Territory. Report of the Department of Agriculture for the Year ending 31st March 1926. Pp. 37. (Dar es Salaam: Government Printer.)

Reports of the Council and Auditors of the Zoological Society of London, for the Year 1926; Prepared for the Annual General Meeting, to be held on Friday, April 29th 1927, at 4 p.m. Pp. 75. (London.)

Transactions and Proceedings of the Royal Society of South Australia (Incorporated). Vol. 50. Edited by Prof. Walter Howchin, assisted by Arthur M. Lea. Pp. iii+350+53 plates. (Adelaide.) 21s.

Year-Book of the Department of Agriculture, Ceylon, 1927. Pp. ii+66+20 plates. (Peradeniya: Department of Agriculture.)

Melbourne Astrographic Catalogue 1900.0. Vol. 1: Zones −65° and −66°. Rectangular Co-ordinates and Diameters of Star Images, from Photographs taken and measured under the Direction of R. L. J. Ellery and Pietro Baracchi, revised and prepared for Publication under the Supervision of Dr. J. M. Baldwin. Pp. xxx+384. (Melbourne: H. J. Green.)

Foreign.

Ministry of Agriculture, Egypt. Technical and Scientific Service. Bulletin No. 60: The Development of the Egyptian Cotton Plant. By M. A. Bailey and T. Trought. Pp. ii+46+18 plates. (Cairo: Government Publications Office.) 5 P.T.

Actes de la Société Helvétique des Sciences Naturelles. 107e Session annuelle du 30 août au 1er septembre 1926 à Fribourg. Pp. 146+306+22. (Aarau: H. R. Sauerlander et Cie.)

United States Department of Agriculture. Department Bulletin No. 1429. The Parasites of *Popillia japonica* in Japan and Chosen (Korea), and their Introduction into the United States. By Curtis P. Clausen and J. L. King and Cho Teranishi. Pp. 56. 15 cents. Department Bulletin No. 1453: The Cheese Skipper as a Pest in Cured Meats. By Perez Simmons. Pp. 56. 15 cents. (Washington, D.C.: Government Printing Office.)

University of California Publications in American Archaeology and Ethnology. Vol. 21, No. 8: The Uhle Collections from Nieveria. By A. H. Gayton. Pp. 305-329+plates 91-97. 35 cents. Vol. 24, No. 1: The Uhle Pottery Collections from Nazca. By A. H. Gayton and A. L. Kroeber. Pp. 46+21 plates. 60 cents. (Berkeley, Calif.: University of California Press; London: Cambridge University Press.)

Proceedings of the United States National Museum. Vol. 69, Art. 10: The North American Two-Winged Flies of the Family Simuliidae. By Harrison G. Dyar and Raymond C. Shannon. (No. 2636.) Pp. 54+7 plates. Vol. 70, Art. 12: Tanaodon, a new Molluscan Genus from the Middle Devonian of China. By Edwin Kirk. (No. 2661.) Pp. 4+1 plate. Vol. 70, Art. 17: Description of a new Dragon Fly from Lower Siam belonging to the Genus Urothemis. By F. F. Laidlaw. (No. 2666.) Pp. 8+1 plate. (Washington, D.C.: Government Printing Office.)

Proceedings of the American Academy of Arts and Sciences. Vol. 62, No. 1: Ants of the Genus Amblyopone Erichson. By William Morton Wheeler. Pp. 29. 75 cents. Vol. 62, No. 2: The Geology of Saint Helena Island. (Shaler Memorial Series.) By Reginald A. Daly. Pp. 31-92+25 plates. 3 dollars. (Boston, Mass.)

International Hydrographic Bureau. Special Publication, No. 19: Ocean Currents in relation to Oceanography, Marine Biology, Meteorology and Hydrography. By Rear-Admiral A. P. Niblack. Pp. 43. (Monaco.) 80 cents.

Bulletin of the National Research Council. Vol. 11, Part 3, No. 57: Molecular Spectra in Gases; Report of the Committee on Radiation in Gases. By Edwin C. Kemble, Raymond T. Birge, Walter F. Colby, F. Wheeler Loomis and Leigh Page. Pp. 358. (Washington, D.C.: National Academy of Sciences.) 4 dollars.

Conseil Permanent International pour l'Exploration de la Mer. Rapports et Procès-verbaux des Réunions, Vol. 42: Investigations of the Production of Plankton in the Oslo Fjord. By Torbjørn Gaarder and H. H. Gran. Pp. 48. Journal du Conseil. Rédigé par E. S. Russell. Vol. 2, No. 1. Pp. 107. (Copenhague: Andr. Fred. Høst et fils.)

Catalogues.

Catalogue of Standard Literature, including Library Sets, Greek and Latin Classics, Modern and Private Press Books, First editions, French Literature, etc. (No. 494.) Pp. 86. (London: Francis Edwards.)

Wild-Barfield Electric Furnaces. Pp. 8. (London: Automatic and Electric Furnaces, Ltd.)

A Complete List of Chapman and Hall's Scientific and Technical Books. Pp. 96. (London: Chapman and Hall, Ltd.)

Diary of Societies.

SATURDAY, April 23.

Faraday Society (in Department of Biochemistry, University Museum, Oxford), at 9.30 a.m., 11.30 a.m., and 2.15.—General Discussion on The Theory of Strong Electrolytes. Part II. Activity.—J. N. Bronsted: Introductory Paper. On the Activity of Electrolytes.—R. H. Fowler: Strong Electrolytes in Relation to Statistical Theory, in Particular the Phase Integrals of Gibbs.—D. L. Chapman: Note on the Theory of Debye and Huckel.—N. Bjerrum: Anomalies in the Theory of Solutions of Strong Electrolytes.—G. Scatchard: Mixed Solutions of Electrolytes and Non-electrolytes.—H. S. Harned: On the Thermodynamic Properties of a few Concentrated Salt Solutions.—F. Foxton and W. J. Shutt: The Activity of Zinc Chloride in Concentrated Solution.—C. A. Kraus: Influence of Salts on Solubility in Non-aqueous Solvents.—J. H. Wolfenden, C. P. Wright, N. L. Ross-Kane, and P. S. Buckley: The Use of Amalgam Electrodes for determining Activities in Methyl Alcohol.—M. Randall: (*a*) The Significance of the Activity Coefficient; (*b*) Methods of Calculation of Activity-Coefficient.—Prof. J. R. Partington: Electrochemical Properties of Non-aqueous Solution of Strong Electrolytes.—Prof. T. M. Lowry: The Definition and Characteristics of Strong Electrolytes.—H. Millet: The Activity of Hydrogen Ion in Mixed Solvents as a Function of Environment.

Institution of Municipal and County Engineers (Eastern District Meeting) (at County Hall, Ipswich), at 10.45 a.m.

North of England Institute of Mining and Mechanical Engineers, at 2.30.—J. S. Carson: The Dry Cleaning of Coal.—The following papers will be open for further discussion:—The Chemical Relations of the Principal Varieties of Coal, Prof. G. Hickling; Screening and Washing Plant at Deaf Hill Colliery, L. F. H. Booth; The Economic Working of Thick Seams in New South Wales, W. Rawling.

Mining Institute of Scotland (at Royal Technical College, Glasgow).—Annual Meeting.

MONDAY, April 25.

Royal Irish Academy, at 4.15.

Victoria Institute (at Central Buildings, Westminster), at 4.30.—Rev. Dr. M. G. Kyle: Ancient Sodom in the Light of Modern Science.

Institute of Actuaries, at 5.—J. G. Baker: Casualty Insurance in the United States of America.

Institution of Electrical Engineers (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.—Annual General Meeting.

Institution of Electrical Engineers (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—Annual General Meeting.

Institution of Mechanical Engineers (Graduates' Section, London), at 7.—H. W. Cadman: Parcel and Package Conveying Plant.

Railway Club (at 25 Tothill Street, S.W.1), at 7.30.—Debate, That the Grouping of British Railways has not been Beneficial.

Aristotelian Society (at University of London Club), at 8.—Dr. G. F. Goldsbrough: Recent Discussions on Time.

Royal Society of Arts, at 8.—J. W. T. Walsh: The Measurement of Light (Cantor Lectures) (1).

Society of Chemical Industry (Chemical Engineering Group) (at 80 Wardour Street, W.1), at 8.—Prof. J. W. Hinchley: Permanent Moulding Machines for Cast Iron.

Royal Society of Medicine (Odontology Section), at 8.—R. C. Sprawson: Further Investigations of the Pathology of Dentigerous Cysts, with a New Treatment Based Thereon.

TUESDAY, April 26.

Royal Statistical Society (at Royal Society of Arts), at 5.15.

Zoological Society of London, at 5.30.—Secretary: Report on the Additions to the Society's Menagerie during the month of March 1927.—Sir A. Smith Woodward: Exhibition of Photographs of some Cretaceous Fishes from the Lebanon.—Dr. R. G. Canti: Exhibition of Cinematograph-films of Living-tissue Cultures showing Cell-division.—Dr. J. Beattie: The Visceral Lymphatic Channels of the Catarrhina.—R. I. Pocock: The External Characters of the Bush-Dog (*Speothos venaticus*) and of the Maned Wolf (*Canis jubatus*).—Edith Berkeley: A New Genus of Chætopteridæ from the N.E. Pacific, with some Remarks on allied Genera.—S. Hirst: Note on Acari, mainly belonging to the Genus Spinturnix, von Heyden.—Marjorie E. Shaw: On a Collection of Sponges from Maria Island, Tasmania.

Institution of Civil Engineers, at 6.—J. P. Porter: Bridge-foundations on Transported Chalk, with Notes on Piled and Monolith Foundations.

Illuminating Engineering Society (at National Physical Laboratory), at 7.—H. Buckley: The Work in the Photometry Department of the National Physical Laboratory.

Institution of Automobile Engineers (Informal Meeting) (at Junior Institution of Engineers), at 7.—Cinema Evening.

Royal Photographic Society of Great Britain (Scientific and Technical Group), at 7.—Dr. T. Slater Price and J. W. Glassett: Thiocarbamide as an Impurity in Thiocyanates.—C. Lighton: A Contribution to the Theory and Practice of the Carbro Process.—J. O. C. Vick: Note on the Performance of the B.P.R.A. Photo-Electric Density Meter.

WEDNESDAY, April 27.

Society of Glass Technology (at Sheffield University) (Annual General Meeting), at 3.—General Discussion on Furnace Efficiency, introduced by A Brief Review of Furnace Developments, Prof. W. E. S. Turner.

Geological Society of London, at 5.30.—F. W. Shotton: The Conglomerates of the Enville Series of the Warwickshire Coalfield.—F. C. Phillips: The Serpentines of the Shetland Islands, and the Associated Rocks and Minerals.

Institution of Civil Engineers, at 6.30.—Annual General Meeting of the Association of London Students.

Institution of Electrical Engineers (South Midland Centre) (at Birmingham University), at 7.—Prof. E. W. Marchant: High-Frequency Currents (Kelvin Lecture).

Royal Society of Arts, at 8.—G. E. Keay: Fire Waste (Loss of Property by Fire) and its Effects on the Economics of National Life in Great Britain (Fothergill Prize Essay).

Institute of Chemistry of Great Britain and Ireland (London and South-Eastern Counties Section), at 8.—G. Stubbs: Some Recent Legislation affecting Chemists.

Royal Society of Medicine (Surgery Section), at 8.30.—Annual Meeting.

British Psychological Society (Medical Section).

THURSDAY, April 28.

London Mathematical Society (at Royal Astronomical Society), at 5.—Prof. E. W. Hobson: On the Integration of Trigonometrical Series.—G. Pólya: Note on Series of Positive Terms.—Prof. H. W. Turnbull: Self-conjugate Polygons for Quadrics and Linear Complexes.—D. R. Ward: Some Series Involving Euler's Function.

Royal Meteorological Society, at 5.30.—Sir Samuel Hoare, Bart.: My Recent Flight to the East.

Child-Study Society (Annual Meeting), at 5.30.—At 6.—Dr. J. N. Glaister and Miss Josephine Richardson: Discussion on Problems in the Upbringing of Children.

Royal Aeronautical Society (at Royal Society of Arts), at 6.30.—Major R. E. Penny: Seaplane Development.

South London Entomological and Natural History Society, at 7.

Institute of Metals (London Local Section) (Annual General Meeting) (at 83 Pall Mall, S.W.), at 7.30.—E. L. Thorne and others: Discussion on The Working of Metals.

Institution of Structural Engineers (at 10 Upper Belgrave Street, S.W.1).—Debate, That the System of Education of Structural Engineers by Articled Pupilage is Contrary to the Best Interests of the Student, and should be Superseded by Education in Recognised Engineering Schools.

Institute of Chemistry (London Section).

FRIDAY, April 29.

Royal Society of Medicine (Disease in Children Section) (at Victoria Hospital for Children, Tite Street, S.W.3), at 4.—Clinical Meeting.

Institution of Mechanical Engineers, at 6.—Prof. F. C. Lea and F. Heywood: The Failure of Some Steel Wires Under Repeated Torsional Stresses at Various Mean Stresses.

North-East Coast Institution of Engineers and Shipbuilders (at Literary and Philosophical Society, Newcastle-upon-Tyne), at 6.—C. Le Maistre: Simplification and Standardisation of Details in Ships and their Machinery.

Institute of Metals (Swansea Local Section) (at University College, Swansea), at 7.15.—Annual General Meeting.

Institution of Electrical Engineers (Scottish Centre) (at University College, Dundee), at 7.30.—D. S. Munro: Modern Electrical Wiring, particularly as applied to Small Houses.

Institution of Engineering Inspection (at Royal Society of Arts), at 7.30.—L. H. Evans: The Stress-strain Diagram and its Application to the Testing of Rolling Stock Draw Gear.

Junior Institution of Engineers, at 7.30.—W. F. Cooper: The Design and Balancing of Three-phase Low-tension Distribution Systems.

Royal Society of Medicine (Epidemiology and State Medicine Section), at 8.—Sir William Hamer: The Influenzal Constitution.

Royal Institution of Great Britain, at 9.—Prof. E. V. Appleton: Wireless Transmission and the Upper Atmosphere.

Diesel Engine Users' Association (at Caxton Hall, Westminster).—O. Wans: Further Developments in Mechanical Injection Oil Engines.

SATURDAY, April 30.

North of England Institute of Mining and Mechanical Engineers (at Neville Hall, Newcastle-upon-Tyne), at 3.—W. S. Rider: Feeding and Treatment of Animals below Ground and Stabling.

PUBLIC LECTURES.

THURSDAY, April 28.

Institute of Pathology and Research, St. Mary's Hospital, at 5.—Sir Almroth E. Wright: On the Treatment of Bacterial Infections by Antibodies and Chemical Agents.

FRIDAY, April 29.

School of Oriental Studies, at 5.30.—Prof. J. P. Vogel: The Development of Ornament in Indian Art. (Succeeding Lectures on May 3 and 5).

CONFERENCE.

April 25 to 28.

German Society for Internal Medicine (at Wiesbaden).—Discussions on Psychotherapy, introduced by Gaupp and Fleischmann; Results of Recent Functional Investigations of the Stomach and Duodenum, introduced by G. Katsch.—A joint meeting with the German Röntgen Society will be held on April 28, with a discussion on the Significance of Röntgen-ray Examination of the Lungs and Mediastinum for Internal Medicine (excluding Tuberculosis), introduced by Dietlen, Assmann, Haenisch and Lorey, and Fleischner.

SATURDAY, APRIL 30, 1927.

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Minerals and Metals of the British Empire.

THE War brought into painful prominence certain facts regarding the resources and distribution of commodities, animal, vegetable, and mineral, which had indeed long been known, but the real significance of which in such a period of stress had not been fully grasped by any one of the Powers concerned. The waste of time, man-power, and material involved in the efforts made to overcome the resulting difficulties created a profound impression, from which flowed a stream of resolutions and good intentions. Meanwhile the years are slipping by and there is yet little indication of an Empire policy regarding minerals and metals.

While it is obvious that the development and conservation of the resources of the British Empire in plant and animal life require all the care and attention that can be given them, the case of minerals is peculiar. It is generally admitted that there is, in accessible form, enough of every mineral in the world to enable its inhabitants to carry on along present lines for a great period of time; but the distribution is unequal, the demand for certain minerals may at any moment overstep the known resources, new sources have to be discovered, and when they have been found and exploited they cannot be rejuvenated or replaced.

One of the lessons of the War was the need for each nation to be fully aware, in detail, of its own resources in minerals and of the means available for rendering them fit for industrial purposes and munitions of war; to be aware also of its actual relations with the rest of the world with respect to resources, transport, marketing, and treatment of minerals. The official statistics available to Governments are practically limited to those of production and of movements, represented by imports and exports. Such statistics, though better than none and essential for certain purposes, convey a totally erroneous conception of the actual resources of a territory; they throw no light on those available for future exploitation; they are always too late to indicate the significance of new finds; and they contain no reminder of the reserves that are fairly accurately known but are not exploited under the fiscal or commercial conditions that are prevalent at the time of their publication. For many years the United States, through its Geological Survey, and later, the Bureau of Mines, has done good service, not solely to its own nationals, by the publication of elaborate statistics relating to the mineral resources of the

States, with such figures as could be assembled regarding other countries, and frequently enlivened by informative reviews of the industry in specific minerals. It was not unnatural, therefore, on ground so well prepared, that Spurr's "Political and Commercial Geology," in 1920, should have stimulated the two leading institutions of American miners and metallurgists to form a joint committee under the chairmanship of Prof. C. K. Leith, to consider and report upon foreign and domestic mining policy and industrial preparedness ("International Control of Minerals." New York, 1925).

This Committee enunciated certain propositions "in the interest of efficient and conservational use of the world's mineral resources and in minimising international difficulties arising from the discovery, development, transportation, and marketing of mineral resources." The propositions put forward cannot be discussed here; in the main, they are equally applicable to any great State. In other quarters there is evident the same desire that these problems should be attacked; quite recently, from Germany, comes a proposal for the formation of an "International Institute of Mines." As things are at present, however, it is more practicable to restrict the field of action to States or federations of States.

The matter has recently been taken up with vigour by Sir Thomas Holland: in a presidential address in 1925 (*Trans. Inst. Min. and Met.*, **34**, 1925, pp. xliv-lxiii), he directed attention to the possibility of shortages of certain base metals in the not very distant future; in 1926, at the Royal Society of Arts ("International Interests in Raw Materials," *Jour. Roy. Soc. Arts*, **75**, 1926, pp. 42-61), he enlarged upon the need for investigation and collection of data regarding the natural resources of the British Empire; this has been followed up by his paper, a "Proposed Review of the Mineral Resources of the Empire," read before the Institution of Mining and Metallurgy on April 21, part of which is printed elsewhere in this issue.

In this paper Sir Thomas proposes that: "In each of the Dominions and, if possible, in each of the larger Colonies, committees of specialists should be appointed and entrusted with the duty of reviewing for each large State or unit of area its mineral resources and smelting capabilities, having in mind the desirability of accumulating, in addition to the ordinary official statistics of production and movement, the essential data necessary for the formulation of an economic policy, as well as for obtaining the information required to institute measures designed to secure military safety."

These proposals are now under discussion in London, and, if approved, it is intended to submit them, with such modifications as may be deemed desirable, for further discussion by the second Empire Congress of Mining and Metallurgy to be held in Canada this autumn. Should the Congress adopt the scheme and proceed to put it into being, there will be for the first time within the British Empire an organisation for the collection of live data and for the prompt examination and elucidation of their implications by men with knowledge of the facts.

The essence of the plan is decentralisation: in each territorial unit, whatever it may be, the special committee would be responsible for the collection and consideration of data within its ambit, and its methods would be those best suited to the local circumstances and special problems. The co-ordinating bodies would be the constituent members of the Empire Council of Mining and Metallurgical Institutions, established at the first Congress, held at Wembley in 1924, in order that each may benefit by the experience of the others, and especially in order that correlation and subsequent economic co-operation by the various Governments may be facilitated at future Imperial conferences of the kind recently held in London.

It is suggested that reports of progress made by the special committees in the Dominions during the next three years should be discussed at the Empire Mining and Metallurgical Congress, which will be arranged to follow that to be held at Montreal this year. The International Geological Congress has shown that it is possible, even with a very loose organisation, to assemble information of a most valuable character on specific subjects, exemplified in the reports on the world resources of coal and iron. The scheme to be laid before the Empire Congress in Canada is more far-reaching: it involves the consideration not only of the mineral resources and their development and treatment in the units of the British Empire, but also of the changing interactions, as adjustments take place due to new discoveries, new methods, new migrations of material, the growth of new industrial centres, and the consequences of political action. In short, to fulfil its functions properly, the proposed organisation must be not only alive but also assured of a prolonged life.

The territorial committees will have to concern themselves with such questions as the conservation of minerals; the encouragement of prospecting; the support of the geological survey, keeping it in touch with realities and advising on the choice of reas ripe for intensive geological investigation; he elimination of wasteful methods of mining, and f movement of ore; and the consideration of uitable centres for refining and smelting. The ocal mining laws should be critically examined with the view of simplification and, so far as ossible, unification. Statistics should be analysed and presented in more useful form.

The discussion of these and other matters would be carried on by the Congress and Empire Council rom the point of view of Empire requirements. Amongst the larger questions might appear that of State ownership of minerals, the inclusion of mining in the public utility services, the accumulation of reserve stocks, fiscal interrelations, etc., which cannot be dealt with by the official and State-aided organisations already existing for the collection and publication of mineral statistics.

While such an organisation as the Imperial Mineral Resources Bureau will doubtless continue to function usefully, the scheme outlined by Sir Thomas Holland would be far more effective in securing the essential details promptly and their consideration by specialists actually in touch with the ramifications of the industry. It is only by some such process that the great industries of mining and metallurgy can be brought into a position from which they can speak with full authority to their several Governments, and thus influence the creation of sound domestic and Empire politics.

An Engineer-Astronomer.

The Scientific Papers of William Parsons, Third Earl of Rosse, 1800–1867. Collected and republished by the Hon. Sir Charles Parsons, K.C.B., F.R.S. Pp. v + 221 + 18 plates. (Newcastle-upon-Tyne: Sir Howard Grubb, Parsons and Co., 1926.)

It is always interesting and sometimes profitable to turn for a moment from the achievements of to-day to contemplate the difficulties, struggles, and aspirations of the pioneer in some special field of scientific endeavour. To do so, however, is not always a simple matter, since it often entails a laborious search through the publications of various learned societies; and, at the end of the search, a feeling that something of importance may after all have been missed. When, however, the whole of the written work of some specialist has been collected together and republished in one volume, it can be studied at any time with the greatest facility.

All those who are interested in the history and development of the reflecting telescope have cause for satisfaction in that this collation of scientific work has been effected in recent years in the case of two of the most distinguished pioneers in the construction and improvement of that instrument.

In 1912 the collected scientific papers of Sir William Herschel were published by the Royal and Royal Astronomical Societies. Among these papers is one which gives a fairly full account of the construction and working of that great 40-foot reflector which may justly be described as the world's first giant telescope, destined not to be doubled in aperture for 130 years. It is only to be regretted that Herschel published very few details of the purely optical part of his work. Fortunately, however, he did commit to writing a very full account of his methods of figuring specula; and, as this manuscript is still extant, it is to be hoped that it may yet one day be published.

We have now before us the scientific papers of William Parsons, third Earl of Rosse, brought together and published in one volume by his son, the Hon. Sir Charles Parsons. These papers, considered in relation to the work of Herschel, may be said to constitute the next chapter in the history of the reflecting telescope. Unlike Herschel, Lord Rosse had no special reason for reticence with regard to his methods, and the full account which he gives of his many optical experiments, successful and unsuccessful alike, makes very interesting reading. Thus, the first paper of the series, written in the days before he had fully mastered the art of figuring his specula to a paraboloid, describes a simple and ingenious method of reducing the aberrations of a spherical surface. This he accomplished by casting a speculum in two concentric parts, with a small space between them. The two parts were then worked together to what was, optically, a single spherical surface. The resulting spherical aberration was then reduced by drawing back the central portion by means of three fine screws. It is rather surprising to read that this apparently crude method proved successful in a mirror having a focal ratio of only 1 to 4; but, as the aperture of this speculum was only 6 in., it seems unlikely that it was called upon to bear very high powers. Yet its maker was so satisfied with it that he declared his intention of constructing one (in three pieces) so large as 18 in. in diameter. But no such instrument is afterwards mentioned, and it appears that Lord Rosse soon turned instead to more promising methods of improving, and more particularly enlarging, his specula.

In this connexion many of Lord Rosse's experiments were directed towards increasing the rigidity of metallic mirrors, and at the same time reducing their weight. To this end he tried the expedient of casting some specula of moderate size with backs braced by straight ribs, and some others with backs of a cellular structure. The results were not altogether successful, and it is interesting to note that similar experiments made on glass mirrors in recent years have also failed to justify expectations.

Most noteworthy, however, of all Lord Rosse's experiments are of course those connected with the casting and figuring of really large specula. The primary difficulty was the successful annealing of large masses of speculum metal in which the copper content was relatively low; for only to such mirrors was it possible to impart a really brilliant and lasting polish. While this difficulty was still outstanding, Lord Rosse turned for a time to an alternative expedient—that of building up a speculum of a number of thin plates of a highly reflective but brittle composition. These plates were soldered side by side to a stout backing of brass, so compounded as to have as nearly as possible the same coefficient of expansion. Except for diffraction effects, caused by the intervals between the plates, this built-up speculum, of 3 ft. diameter, seems to have been entirely successful.

Meanwhile a solution to the annealing problem had been found. It consisted in the casting of specula on a bed of hoop-iron packed tightly on edge. This promoted the rapid and regular cooling of the metal from below upwards, and by its means Lord Rosse was able successfully to cast specula of 6 ft. diameter. Two of these were eventually cast for use in the great reflector which marked the crowning point of the efforts of this tireless experimenter. The actual figuring of these great masses of metal, weighing three or four tons apiece, seems, strangely enough, to have presented comparatively little difficulty. It was of course necessary to devise special grinding and polishing machinery, all of which is fully described and illustrated in the papers; but previous experience with smaller specula had apparently done much to smooth the way for this greater undertaking. Much more serious was the difficulty of so mounting the finished mirror as to free it from the risk of flexure. However, this difficulty was almost completely met by mounting the speculum on a series of triangles, supported by levers, after the plan devised by Thomas Grubb. The design and erection of a mounting for the great telescope gave plenty of scope to the engineering ability of its constructor; and it is here worth remarking that the entire instrument was from first to last the product of local labour, under the instruction of Lord Rosse himself, and that the total cost was only £8000.

The actual work done with the great telescope, especially in revealing for the first time the spiral structure of certain nebulæ, is a matter of astronomical history, and need not here be described. One point, however, brought out clearly in the detailed description of the telescope's performance, seems worthy of emphasis in view of statements sometimes to be found in less authoritative accounts. We refer to the defining power of the great speculum, which has often been described as being of a distinctly inferior order. That there were many occasions when, in the climate of Ireland, such a telescope would perform but poorly, will be readily understood by all who have worked with large apertures; also it appears that flexure was occasionally a source of trouble; but, on the other hand, it is equally clear, from details given here and there in the papers, that the telescope did at times perform splendidly, even under high powers, which it certainly could not have done had the figure of the speculum been appreciably defective.

The volume closes with some interesting extracts from the correspondence of Lord Rosse bearing on the early history of the 'ironclad.' Apart from any value they may have had at the time they were written, they serve to illustrate the versatility of this remarkable man; and it seems worth remarking that they were destined to be by no means the last contributions of the Parsons family to the science of marine engineering.

W. H. S.

Specialised Plant Tissues.

(1) *Handbuch der Pflanzenanatomie.* Herausgegeben von Prof. K. Linsbauer. Abteilung 1, Teil 2: *Histologie.* Band 4: *Meristeme.* Von Dr. Otto Schüepp. Pp. vi + 115. 8·70 gold marks. (2) Band 5: *Die Bewegungsgewebe.* Von Prof. Dr. Hermann von Guttenberg. 25·50 gold marks. (Berlin: Gebrüder Borntraeger, 1926.)

(3) *Das Archiplasma: Betrachtungen über die Organisation das Pflanzenkörpers.* Von Prof. Dr. Hugo Miehe. Pp. vi + 92. (Jena: Gustav Fischer, 1926.) 4 gold marks.

(1) DR. SCHÜEPP'S own contributions to our understanding of the part played by the plant meristem are a guarantee that this section of the new handbook of plant anatomy is in safe hands. He points out that after a period, from 1870 until

880, when the meristem, and especially the growing point, was the centre of botanical interest, he subject has somewhat fallen into the background, to be brought forward again to-day, to some extent, in the attempt to understand some of the phenomena of graft hybridisation and especially periclinal chimæras. It is interesting, therefore, to see how concepts that were formulated in an earlier period of botanical activity fare when made the basis of treatment in a modern monograph of the subject.

Dr. Schüepp presents the subject as a problem requiring elucidation from the viewpoint of causal anatomy, but he is not inclined to attach great significance to attempts to explain cell division, its order and direction, along the lines of simple physical laws, as foreshadowed to some extent by Berthold in his "Stüdien über Protoplasmamechanik." He discusses the different types of apical meristem of the vascular cryptogam and the lowering plant, finding a transition between the apical cell of the former and the uniform meristematic tissue of the latter in the initial cells of the apex of the axis of the Lycopodiales and Gymnosperms. The initial cell is not an apical cell, because it is not characterised by special size, orm, or manner of division, but it is a cell or group of cells from which all the tissues of the growing region derive. In the Gymnosperms, Haustein's distinctions of dermatogen, periblem, and plerome cannot hold, even the dermatogen showing occasional periclinal divisions, and the result of the discussion is evidently to minimise their importance in the complex construction of the Angiosperm apex. For the root another distinction of 'cap' and 'core' is drawn, the cell series in these two regions arising from the 'urmeristem' by a different order of cell division, which affects their symmetry as derivatives of the active apical meristem. Root systems are then classified according to the relative share these two tissues play in the differentiated root; the cap may only form the root cap—on the other hand, it may form every tissue from the outside of the root cap down to the endodermis.

Embryonic meristems are also briefly discussed, Sonèges being chiefly followed here, but the monograph is mainly valuable for its clear and critical discussion of the activity of the apical meristems of shoot and root. It is interesting to see that the theory that the endodermis acts as a tissue-absorbing pocket, in advance of the growing point of the secondary root, is given on the authority of the earlier workers without comment, though it has been thoroughly negatived by Friedrich Lenz (in 1910–11) and is not supported by any modern experimental work so far as is known to the reviewer.

(2) Prof. Guttenberg has made a very full compilation of the literature in a somewhat artificially delimited field of plant anatomy. Naturally the treatment is of adult tissues, without consideration of development, and from a strictly teleological viewpoint. The classification adopted in the same field by Haberlandt is followed without alteration.

Tissues involved in active movements such as dehiscence or growth mechanisms, etc., are first distinguished from tissues concerned in passive movements, such as the floating mechanisms of water-dispersed seeds and fruits. Tissues concerned in active movements are classified as dead or living tissue systems. In the dead systems those depending upon hygroscopic movements in anisotropic wall systems are distinguished from mechanisms such as the fern annulus, which depend upon the cohesive pull upon elastic walls, exerted by the gradual diminution of the water content in cells full of water. There is a very brief discussion of growth curvatures, as these are not usually associated with special tissue systems. A brief description of stomatal movement is found amongst living tissue systems associated with movement; this discussion is restricted to the effect of the histology of the guard cells and other special cells upon the movement mechanism. A very complete bibliography is included.

(3) In this monograph Prof. Miehe passes in review many of the puzzling facts associated with the capacity for reproduction, especially vegetative propagation, of the plant. He then suggests that the capacity of a cell to construct new protoplasm and then multiply by division, in other words, the meristematic properties of the cell, may be a function of its content in a special type of protoplasm, the 'archiplasm.' Cells of the permanent tissue, incapable of reproduction, are then deficient in this 'archiplasm.' Prof. Miehe terms them 'ergoblasts' as compared with the potentially reproductive 'archiplasts,' which in the meristem of a growing point may be massed in an 'archenchyma.' This new viewpoint evidently admits of a re-interpretation of well-known phenomena in terms of a new phraseology, but as the 'archiplasma' cannot be recognised save by its effects on reproduction, and as no new experimental method of attack is suggested, it is questionable if it does much more. It at least puts upon record

Prof. Miehe's view that all living cells of the plant cannot be regarded as 'totipotent' in reproduction, a viewpoint towards which Vochting's experiments had led him.

This theoretical conception of the 'archiplasm' is applied in a very brief general review of reproduction and regeneration in the plant. The subject is one on which generalised statements are difficult to make, and two are noted to which exception can certainly be taken, namely, the statements (p. 37) that adventitious roots arising upon shoots always appear in the pericycle, and (p. 39) that the phellogen is a tissue which is never associated with the origin of buds.

Synoptic Psychology.

Mind and Personality: an Essay in Psychology and Philosophy. By Dr. William Brown. Pp. x+344. (London: University of London Press, Ltd., 1926.) 12*s.* 6*d.* net.

ALL those who are well acquainted with recent psychological thought must turn with unusual interest to a comprehensive expression of the views of Dr. William Brown. This they will find set forth in the volume now offered to us, which—to use the author's own words—is "an attempt to obtain a synoptic view of personality, as considered from the standpoints of the various sciences—especially from those of psychology, psycho-pathology, and philosophy."

Besides these three sciences, however, there might well have also been made a claim for physiology. For from this latter it is that Dr. Brown first embarks upon his course, and in a definitely anti-mechanistic direction. "Although the body," he says, "does obey physical and chemical laws, processes nevertheless go on in it which are inexplicable in those terms." Among the non-mechanical characteristics of bodily conduct he enumerates "spontaneity," "persistence of action after the stimulus producing the action has disappeared," "the coming to an end of the activity after a certain purpose has been achieved," "the power of learning by experience," the action of "the organism as a whole"; in short, the fundamental fact that "all animal behaviour is purposive."

Turning to the point of view of psychology, we find that the author rather curiously trisects this into "psychology" pure and simple, "experimental psychology," and "child psychology." Dominating the first of these three divisions comes for him the conception of the mind "as a system of interests, with emotional reactions, showin different degrees of unity in the systems of sub ordinate unities; these systems being incorporate in wider systems, and these wider systems agai being incorporated in still wider systems, till at las one has a total system dominated by one al satisfying interest." As for "volition," this h takes to consist of "the whole character in actio with the sentiment of self-respect in command. In his second or "experimental" division c psychology we come upon an assortment of suc topics as psycho-physical methods, cutaneou sensibility, visual experience, mental variation and mathematical ability. His third and las division, that which deals with the child, is mos notable for warning that undesirable juvenil propensities should be counteracted, not b "repression," but instead either by "substitution ' or else by "sublimation."

From the author's next scientific point of view that of psycho-pathology, he strongly defends the distinction that has been drawn between "organic ' and "functional" nervous disorders. As regard the latter, he urges that "physical and physio logical methods of treatment have shown them selves thoroughly inadequate to cope with th situation." In their place he recommends, no so much "psycho-analysis" in particular, a rather "deep analysis" in general. This supplie a procedure whereby to resolve the abnorma systems of interests called "complexes," as als possibly the normal systems called "sentiments.' Here — and indeed almost throughout — he i greatly influenced by the teachings of Freud which he either admiringly accepts or else sharply contests. An example of the critical attitude i his emphatic rejection of the belief that a young child has ever present a strong feeling of hostility towards the parent of like sex. He furthe repudiates the suggestion that the unity of the mind has been proved to be a comparatively late mental product. On the contrary, he says, "the results of psychological analysis itself show an underlying thoroughgoing unity."

The author's third or philosophic point of view brings him to the topic of ethics; and here he ranges himself on the side of the intuitionist school Turning, next, to the theory of evolution, he proceeds to combat the "aimless freedom of spontaneous activity and pure duration" advocated by Bergson, and would substitute in its place the "real freedom of deliberate choice." Then follows his treatment of the problem which appears to have for him the deepest interest of all; it is that of religion, which he defines as an attitude "of personal relationship towards the universe." This leads him, finally, to the region of mysticism, where his counsel is that we should seek to transcend time and in such wise follow the exhortation of Aristotle "to be immortal as far as possible even in this life."

On the whole, Dr. Brown ranges over an extraordinarily wide field. But for so doing he can at least claim the high sanction: *Wer vieles bringt, wird manchem etwas bringen.*

C. Spearman.

A New Approach to Zoology.

The Elements of General Zoology: a Guide to the Study of Animal Biology, correlating Function and Structure; with Notes on Practical Exercises. By Prof. William J. Dakin. Pp. xvi + 496. (London: Oxford University Press, 1927.) 12*s*. 6*d*. net.

Zoology has been suffering during recent years under the unjust and wholly undeserved criticism that it does not readily lend itself to experiment and is therefore, in this respect, inferior to botany as a subject for inclusion in the school curriculum. It is true that there is still a tendency to lay too much stress on structures and to neglect the functions served by those structures, but this is the fault of the teachers rather than the subject. Prof. Dakin's book is at once a complete justification of the right of zoology to be considered as an experimental subject for school work, and a guide to the teacher as to how the relative claims of function and structure can be adequately met in their courses. Function is the dominating note of the book and, except for a chapter specially devoted to the Protozoa, the subject matter is arranged under the headings of the various functions of animals and not under the customary systematic groups. In dealing with any one function, the author has given just so much structural detail of the organs concerned as is necessary for a proper comprehension of their uses, and has saved much valuable space by the free use of carefully annotated drawings and diagrams to impart the details of anatomy.

Among the most valuable parts of the book are the experiments, which are carefully outlined in each chapter, for practical demonstration of the physiological processes underlying function. The material chosen for these experiments is readily obtainable and easy to manipulate; the experiments themselves are simple and the apparatus inexpensive. With these as their guide, teachers should have little difficulty in making intelligible, even to their younger pupils, the life processes of the living animal. They will at least be able to make zoology a living science.

The book is intended mainly as a guide to the study of animals through their functions, but in order to meet the needs of laboratories where one type is studied at a time in the practical classes (and this must inevitably be the case in most school laboratories), the author has assembled in the index all references to a particular type under one heading, so that the book readily lends itself for use as a practical text-book from the systematic point of view. Special praise must be accorded to the illustrations. Not only are they clearly and beautifully reproduced, but also they have been chosen with great care, and in nearly all cases have been modified and specially annotated. Their value has been enhanced enormously thereby.

Prof. Dakin has, in our opinion, abundantly justified the preparation and publication of this book. It strikes a new note in text-books of zoology, and should prove of incalculable help to teachers of biology in schools, while university teachers will find much in it of real use for their intermediate courses. It is the most refreshing and stimulating text-book, from the teachers' point of view, that has been published for some time The Oxford Press deserves special commendation, not only for the admirable way in which the book has been produced, but also for its remarkably low price.

Our Bookshelf.

Ancient Cities and Modern Tribes: Exploration and Adventure in Maya Lands. By Thomas Gann. Pp. 256 + 32 plates. (London: Gerald Duckworth and Co., Ltd., 1926.) 21*s*. net.

For several years past, Dr. Gann has published annually a volume containing an account of his adventures and experiences while engaged in archæological exploration in Central America during the preceding winter. Entertaining and instructive as the preceding narratives have been, the present surpasses them in interest, as it contains not only an account of the further exploration of the remarkable site of Lubaantun, opened up in the preceding year, but it also records one of the most sensational discoveries hitherto made in American chronology, as well as the revelation of an entirely new and unexpected centre of Mayan culture, of which many features are unique.

Any one of these achievements would have served to assure the success of the expedition from the scientific point of view, and would have afforded ample compensation for the hardships it entailed.

The dated stela found at Chetumal Bay shows an Initial Series which, on Spender's correlation, corresponds to Oct. 26, A.D. 333. This is the earliest of the four series found in Yucatan by nearly three centuries, and shows that the Maya had obtained a foothold in this part of the country long before it was supposed to be inhabited at all. Dr. Gann, after visiting the "Cave of Flowers," which he suggests with reason may yield to exploration vestiges of early man, went on to Coba, attracted thither by a suggestion in a recent translation of an ancient Maya manuscript. The gigantic causeway leading to the site must be, in its way, one of the most remarkable achievements of Maya mechanical skill, while the temple mound at Coba itself is probably the highest in Yucatan. The special interest of the site, apart from the many peculiar characters of its three types of Maya civilisation, lies in the fact that it does not appear to have come under Toltec domination—a fact which will undoubtedly prove of no little importance when the exact bearing of Dr. Gann's discoveries on Maya history has been worked out.

It has not been possible even to touch upon the many matters of the greatest archæological interest to which Dr. Gann himself has sometimes only been able to refer in passing, and a more extended and detailed report will be eagerly awaited. It must not be thought, however, that Dr. Gann has confined himself to matters archæological. His account of the incidents of his journey and of the people he met are, as usual, both informative and amusing.

Zoologisches Wörterbuch: Erklärung der zoologischen Fachausdrücke; zum Gebrauch beim Studium zoologischer, anatomischer, entwicklungsgeschichtlicher und naturphilosophischer Werke. Verfasst von Prof. Dr. E. Bresslau und Prof. Dr. H. E. Ziegler. Unter Mitwirkung von Prof. J. Eichler, Prof. Dr. E. Fraas, Prof. Dr. K. Lampert, Prof. Dr. Heinrich Schmidt, und Prof. Dr. J. Wilhelmi. Revidiert und herausgegeben von Prof. Dr. H. E. Ziegler und Prof. Dr. E. Bresslau. Dritte vermehrte und verbesserte Auflage. Pp. viii + 786. (Jena: Gustav Fischer, 1927.) 28 gold marks.

THE proof of the first half of this new edition was corrected when the sudden death of the senior author, Prof. H. E. Ziegler, occurred on June 1, 1925. Prof. Bresslau has therefore been responsible for the revision of the second half of the volume. The aim of the book is to give a definition or brief explanation of the terms used in zoology, of the classes and orders of animals, of the most important families, and of those genera which are of special significance from a theoretical or from an economic point of view. The classical origins of the terms and of the generic names are given, and in many cases the author of a term is cited, *e.g.* "Gastrula (Haeckel, 1872)."

The authors must have been often faced with the difficulty as to what to include and what to omit, and individual readers will no doubt wish that more could have been included. For example, Gyrodactylus and mitochondria receive notice, but Gyrocotyle, Stegomyia, and the Golgi apparatus are omitted. Errors appear to be remarkably few, Bilharzia is said to occur in the kidney, the fleas are stated to form a single family (modern practice is to divide them into two families), and Geotria is referred to as a South American genus, whereas three of its four known species are Australasian.

The cross references are in several cases out-of-date, *e.g.* under Ancylostomum (the official spelling is Ancylostoma) the reader is referred to Dochmius, and under Giardia to Cercomonas, but Ancylostoma and Giardia are the names now in use, and the description should be under these heads and not under the obsolete names. The illustrations (575 in number) are on the whole good, but a few are unsatisfactory, *e.g. Balantidium coli*, *Pulex irritans*, malaria and Sarcocystis (especially the spores). But these are small blemishes in a work so large and so difficult to prepare. The volume may be recommended as a helpful and trustworthy work of reference.

Electrical Contracting: a Guide and Handbook specially designed to meet the Needs of all those engaged in Business as Electrical Contractors. By H. Ayres Purdie. Pp. xxxii + 375. (London: Ernest Benn, Ltd., 1926.) 10*s*. 6*d*. net.

ELECTRICAL contractors form a very important section of the engineering industry. It is curious, therefore, that so few books are published to meet their needs. It is necessary that they should know the best method of organising their businesses, preparing estimates, reading and supplying specifications, and preparing schemes for lighting, heating, and power. They have also to know the best materials to use in given cases.

We think that this book under notice will be found of practical use to contractors. In an introduction, stress is laid on the importance of good workmanship. To have cheap materials properly installed by a conscientiously competent workman is much preferable to having good materials casually and carelessly installed. Screwed steel conduit, for example, even when of the best quality, does not signify a safe installation if improperly fitted up. Special care has to be taken when choosing switches for bathrooms, kitchens, cellars, and so on. It is specially important also that the 'earthing' of the conduit be efficiently done. Useful information is given on illumination work, the number of foot candles required for all kinds of lighting being specified. The methods of installing electrical signs are described. We are told that the well-known 'neon' illumination of the Coliseum, Charing Cross, London, and the enormous *Daily Mail* sign at Blackfriars Bridge over the Thames, consume only 22 and 15 units per hour respectively. The high-tension side of these signs, which operates at pressures not less than 2000 volts and is consequently dangerous, is erected by the makers themselves. It is pointed out that it is sometimes advantageous to work the electric bells in a house from the alternating current supply.

The Steam-Engine and other Heat-Engines. By Sir J. Alfred Ewing. Fourth edition, revised and enlarged. Pp viii + 662. (Cambridge: At the University Press, 1926) 25*s.* net.

THIS well-known work, which on its first appearance in 1894 set up a new standard of excellence in the writing of text-books on this subject, now appears as a fourth edition extensively revised and enlarged. In its pages students can gain a very good idea of the history of the development of heat-engines, while the basic thermodynamic theory is expressed with a notable clarity, simplicity, and scientific accuracy.

In new editions of standard text-books the additions are always of especial interest, and we now find here an enlarged section on the theory and practice relating to steam turbines, which in about a hundred pages gives an admirable survey of the subject. It is perhaps not possible now to give so connected an account of the internal combustion engine, which has become a serious rival to the steam turbine for the propulsion of ships. The battle is still being waged, but whatever may be the issue, applied science gains by the researches of Callendar and others on the properties of steam at great pressures and high superheats, and by the various investigations on the properties of the explosive charge in the cylinders of internal combustion engines, described in this volume. Many other subjects, arising from the great sizes of the engines now being designed and built, are dealt with; much research on these subjects has been carried out, and is still proceeding, in order to provide successfully for motive power in units of unprecedented size.

Students will be especially grateful for a text-book which covers so wide a range and brings them up to the boundary of existing knowledge.

E. G C.

Floræ Siamensis Enumeratio: a List of the Plants known from Siam, with Records of their Occurrence. By Prof. W. G. Craib. (Published under the Auspices of the Siam Society.) Vol. 1, Parts 1 and 2 · *Ranunculaceæ* to *Anacardiaceæ* Pp. 1-197 and 198-358. (Bangkok: *Bangkok Times* Press, Ltd.; London . Luzac and Co., 1925 and 1926.) 7 Tcs ; 12*s.* 10*d.* each.

A USEFUL compilation, of which the first two parts have appeared, is in course of publication. It is a catalogue of all plants collected in Siam, with a full record of collectors' specimens, references to literature and synonymy, together with occasional notes by the author, who has critically examined, wherever possible, the type specimens and other specimens quoted. The local Siamese and Malay names are given. No new species are recorded, though very many of those listed have been described by the author himself in the *Kew Bulletin* from material supplied by recent collectors, chiefly Dr A. F. G. Kerr, Mrs. D. J. Collins, and members of the Siam Forest Service.

The geographical situation of Siam lends special importance to its flora, for it is a focus for intrusive plants from south-west China, Burma, and the Malay Peninsula. Possibly also (with the adjacent countries which go to make up Indo-China) it has been a centre from which certain species have been disseminated. It must, therefore, have a considerable bearing on the floristic relationship of those different regions.

C. FISCHER

Crime and Custom in Savage Society. By Dr. Bronislaw Malinowski. (International Library of Psychology, Philosophy and Scientific Method.) Pp. xii + 132 + 6 plates. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., Inc., 1926.) 5*s.* net

PART of this stimulating essay on primitive jurisprudence was delivered by Dr. Malinowski as a lecture at the Royal Institution and published in extended form in our columns (NATURE, Feb. 6, 1926, Supplement, p. 9). It is scarcely necessary, therefore, to do more than direct attention to its publication in book form, and to say that in the added matter the author has amplified his main contention that much of the general theory of the older school of anthropology fails to stand the test to which it can be submitted by the field-worker. In the present instance, in the field of primitive jurisprudence, Dr. Malinowski. with his acutely critical power of analysis, is able to show from his experience among the Trobrianders that the idea of group dominance is inadequate as a sanction of law and order in primitive society.

The Garden Interests of Madeira. By Dr. M. C. Grabham. Pp. xii + 100 + 3 plates. (London: Printed by William Clowes and Sons, Ltd., 1926.) 5*s.*

DR. GRABHAM has written an interesting and useful little book on the plants found in gardens and growing wild in Madeira, which should be of value to visitors to this favoured island In the second part the plants are discussed under their respective families and useful notes are given about them. The first part contains a good deal of miscellaneous information about the plants and their times of flowering, the various fruits and vegetables to be met with at different seasons, and other matters of interest to the visitor. This part fittingly contains at the end a portrait of the venerable and versatile author bearing the legend, "Archangelicus maderensis!"

The Way of the Wild. By H. R. Sass. Pp. vii + 321. (London · T. Fisher Unwin, Ltd, 1926.) 7*s.* 6*d.* net.

A SERIES of ten animal stories dealing with the adventures of a wide range of North American creatures, from owls and eagles to racoons, pumas, and bison. The stories are linked with the experiences of white hunters and Indians; they are well written, full of interest and excitement, and the author has avoided the danger of swamping the soundness of his natural history by a too vivid imagination. The value of the book lies in the likelihood that it may arouse in many who are not naturalists an appreciation of and sympathy with the lives of wild creatures, and naturalist and non-naturalist will enjoy the stories.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

X-ray Investigation of the Polymorphism of Fatty Acids.

During recent years X-ray analysis has been successfully applied to the investigation of long-chain organic compounds. The method seems especially adapted to the study of polymorphism of such substances (Piper, Malkin, and Austin, *Jour. Chem. Soc.*, 1926; 2310. G. M. de Boer, Nature, Jan. 8, 1927. J. Thibaud, *C.R.*, 184, 24, 96; 1927).

The easiest method to follow is to make a thin film of the substance on a glass strip (by melting or by crystallising from a solution) and to use this as a 'turning crystal' in the X-ray spectrograph. By exposing the film to monochromatic X-rays, rather sharp lines are obtained, which are due to a *long spacing* present in the micro-crystalline film. This long spacing is a beautiful characteristic of the modifications of the substance which sometimes gives information not so well afforded by an investigation of other physical constants as the heat of transformation.

In continuation of such former work, I have studied in this manner the influence of temperature on the modifications of the odd and even saturated fatty acids. For this purpose the preparation was placed inside a small thermostat, which was mounted on the crystal table of the spectrograph For the passage of the X-rays the thermostat was fitted with two windows covered with goldbeater skin. By electric heating it was possible to obtain temperatures from room temperature up to 60°, the temperature being measured with a mercury thermometer.

Using copper $K\alpha$ radiation, photographs were taken at different temperatures showing the lower orders of reflection of the long spacing. The distance between the third and fifth orders was measured, and from this the spacing was calculated.

The data obtained with the *odd* acids, which behave differently in general from the even acids, are summarised in the following table:

Acid	Melting Point	Transition Point	Spacing of the Modification		
			At Lower Temp.		At Higher Temp
			β_I	β_{II}	α
	°C	°C	Å U	Å U	Å U
$C_{11}H_{22}O_2$	28·2	17	30 1	..	25·4
$C_{13}H_{26}O_2$	41·2	32	35·1	31·5	29 8
$C_{15}H_{30}O_2$	52·1	44	39·7	35·9	34·4
$C_{17}H_{34}O_2$	60·6	54	..	40·2	38·7

At the transition point, the β-modifications pass into the α-modification and vice versa

The presence of *two* β-modifications in the table needs some further explanation:

At the lower temperature, in the case of C_{11} and C_{13}, all specimens showed the 'β_I-spacing,' whereas films of C_{15} and C_{17} always showed the 'β_{II}-spacing.' It was possible, however, to obtain in some ways films of C_{13} showing not only the β_I- but also the β_{II}-spacing, and films of C_{15} showing, besides the β_{II}-spacing, also the β_I-spacing. When these films, however, after first being transformed into the α-modification, were again cooled down below the transition temperature, the α-lines of course disappeared, but only lines due to *one* β-modification reappeared. In the case of C_{13} this was the β_I-modification, in the case of C_{15} the β_{II}-modification.

From this we may conclude that the β_I-modification is the stable one of C_{13} and the β_{II}- of C_{15}. It must be observed, however, that heating the preparation for several hours at about 2° below the transition point did not seem to have any influence on the relative intensities of the lines due to the two β-spacings. This proves that if it should be possible to transform immediately the less stable form into the more stable one, the rate of this transformation at least must be very slow.

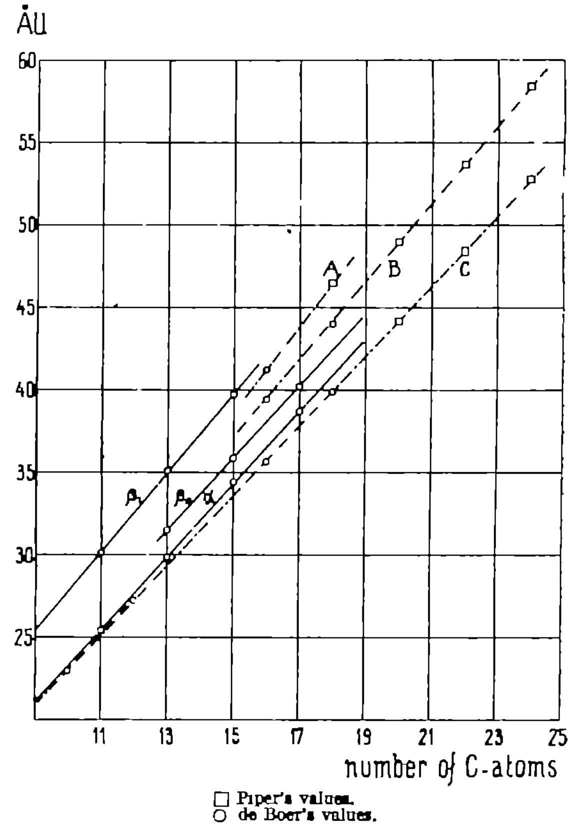

Fig 1—Spacing constants as a function of the number of C-atoms of the molecule. The dotted lines relate to the even acids, and the continuous lines to the odd acids

Though several trials were made under different conditions, I never succeeded in observing a β_{II}-modification of C_{11} or a β_I-modification of C_{17}.

For some of the *even* fatty acids Piper has found three different modifications at room temperature which he calls A-, B-, and C-modifications. According to Piper, these modifications are independent of the temperature, their occurrence depending only on the way the preparation is obtained.

In the present investigation, however, I could show that these modifications are also influenced in a certain way by temperature For example, starting with a preparation of palmitic acid, which showed at room temperature three modifications at the same time (spacings A 41 2; B 39 5; C 35·8 Å.U.) and heating at 45° for three hours, the B-lines had nearly disappeared, the A-lines persisted in about the same intensity, whereas the C-lines had much increased. Raising the temperature to 50° for two hours, the A- and B-lines both had wholly disappeared, whereas only C-lines appeared on the plate. Raising again the temperature to 59°, no further changes occurred. On cooling down again to room temperature, a photograph was obtained identical with that at 59°; no A or B spacing reappeared. In the case of stearic acid, starting with a film which showed only the B-lines at room temperature, after heating to 55° only the C-lines were observed. In the case of capric and lauric acid, only the C-modification was found at room temperature, which remained unchanged when heating at some degrees below the melting temperature.

Thus the even fatty acids seem to have only monotropic modifications of which the C-modification is the stable one.

In the accompanying diagram (Fig. 1) the spacings observed are plotted against the number of carbon atoms of the corresponding molecule. So far there seems to be no simple relation between the spacings of the even and the odd acids.

Our results seem to confirm some suggestions already given by Garner (Garner, Madden, and Rushbrooke, *Jour. Chem. Soc.*, 1926; 2491).

I have to thank Mr. J. A. Prins for much helpful advice during the course of the work.

In conclusion, I wish to express my thanks to Prof. P. E. Verkade, of Rotterdam, for supplying several pure fatty acids, and to Prof. W. E. Garner, of London, who put some pure heptadecylic acid at my disposal.

G. M. de Boer.

Natuurkundig Laboratorium
der Rijksuniversiteit,
Groningen (Holland).

The Nuptial Pad of Kammerer's Water-bred Alytes.

Some time ago a friend of mine who was interested in my amateurish experiments on frogs took some pictures which he intended for publication. He found it necessary to bring out some of the natural markings with ink so that they would reproduce better in print. I am wondering if the marking of Kammerer's specimens which led to his suicide might not have an equally simple explanation.

Walter C. Kiplinger.

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Kammerer's untimely death has confronted us with three problems, seeming intrinsically interwoven, but, as it appears now, distinct enough to be dealt with separately: they are—

(1) The motives of his suicide; (2) the mystery of the 'doctored' specimen; (3) the validity of the original experiments on the nuptial pads in Alytes.

The first question is chiefly psychological, the second criminal, while only the third concerns biological science proper. Whilst we can conjecture the motives of Kammerer's weariness of life (see *Monistische Monatshefte*, 11, 401, Nov. 1926; R. Wettstein, *Neue Freie Presse*, Dec. 16, 1926), we are at a loss as to the person who may have injected specimens with Indian ink or with what intention this may have been done. It seems not impossible that Mr. W. C. Kiplinger's suggestion is correct and that the injection was intended to enhance a faded appearance in order to get a good photograph, although the existence of other doctored specimens does not seem to be in favour of this version. A picture was taken in September 1922, not in the Biologische Versuchsanstalt, but in the photographic studio Reiffenstein, of the well-known specimen, and only from thence onwards do the mis-statements begin. On the other hand, up to 1919 the descriptions and figures of nuptial pads in Alytes given by Kammerer do not fit in with this specimen. We are therefore able to exempt any one who died before 1919, or had no contact with the Institute after that year, from any suspicion at having made the injection; for example, Dr. F. Megušar, who was killed at the Wolhynian front on Aug. 3, 1916 (see *Archiv fur Entwickl.-mech.*, 42, 222; 1917).

We have been able to collect five proofs that in his original papers Kammerer was not hampered by the doctored specimen which has invalidated his remarks on the same subject in his books "Inheritance of Acquired Characteristics" (1924) and "Neuvererbung" (1925). By comparing dates and photographs we can now formulate these proofs even before the new experimental evidence which Kammerer's collaborators in Moscow are trying to get is available: the proofs are as follows:

(1) In Kammerer's original papers the nuptial pad in Alytes is described and pictured as being "on the dorsal side of the thumb and on the thumb-ball" (1909, p. 516, fig. 26*a*), "on the dorsal and radial side of the first fingers" (1919, p. 336), and "across the thumb-ball on the whole internal side of the fore-arm to near the elbow" (p. 337, tb. x, fig. 2), in accord with the general appearance of nuptial pads. Even in 1923, when Kammerer showed a lantern slide of the critical specimen before the Zoological Society of London, he did not mention the disposition of the nuptial pad on the whole palm of the hand (see Bateson, Nature, Dec. 22, 1923, and letter to Przibram). It was not until the photographs of this specimen were used in his books (1924, p. 53, fig. 9 to the right; 1925, fig. 9, facing p. 20) that Kammerer mentions and defends the untoward position of the pad in the palm and on the outer border of the last (fourth) finger.

(2) The photograph in his original paper (1919, tb. x. fig. 2), taken by E. B. Congdon (see *ib.* p. 369) in Kammerer's and my presence in 1913 (letter of Congdon, professor at the Chulalangkara Medical School, Bangkok, Jan. 8, 1927), shows a narcotised Alytes with nuptial pads on the radial side of hand and arm.

(3) The drawings by Kaspar of microtome sections (Kammerer, 1919, p. 370, tb. 11, figs. 7, 9), and the photos thereof by Prof. H. Joseph (*ib.* tb. 10, fig. 4), relate to skin taken in 1913 (see *ib.* p. 331) from the hands of Alytes in Kammerer's presence by Olga Kermauner, sister of Prof. Kermauner, of the University of Vienna, now married to Mr. Critikos. This lady histologist herself prepared all the slides and remembers having been struck by the difference in those of the water-bred Alytes as compared with the normals from the beginning (letter by Mrs. Olga Critikos, 914 Leland Ave., Chicago, Dec. 15, 1926).

(4) Comparing the known forms of nuptial pads in other species as to their horny spicules (Lataste, Meisenheimer, Harms, Kandler, etc.) with these drawings and photos of Alytes, there seems to be full specificity of these structures. Even the sections of *Bombina maxima*, the nearest approach to Alytes, can easily be distinguished from the photographs and drawings which Dr. Noble (Museum, New York) has sent me. The species *B. maxima* was not known to Kammerer and has never been kept alive at our Institute (see list of animals, *Zeitschrift biol. Technik u. Methodik*, 3, 163; 1913, p. 214).

(5) The histological features of Kammerer's sections of nuptial pads in Alytes are furthermore identical with those of a specimen found in Nature by R. Kandler (*Jenaische Zeitschrift*, 60, 175; 1924, tb. x. fig. 12) with rudimentary nuptial pads. The stratification and relative nuclear sizes of the said sections

are also exactly duplicated by those of sections taken from normal Alytes (Kammerer, 1919, tab. 11, figs. 1. 2, and photographs sent by Dr. Noble).

These five proofs being each conclusive and independent of each other, I should think the nuptial pads in water-bred Alytes must be seriously taken into consideration, unless some one should offer another explanation of the coincidence of the five points raised here.

Hans Przibram.

Vienna II., Prater,
Vivarium, Mar. 26.

Science and Food Production.

In the very sympathetic notice of my book, "Plant Nutrition and Crop Production," in Nature of Mar. 26, p 454, the reviewer raises the interesting question how far science has actually helped in increasing the production of food. Statistics show that, in spite of the scientific work, the yield of wheat per acre in England is not much greater than it was fifty years ago, and it is implied that scientific work has in practice achieved little, however interesting its results may have been from other points of view.

The statement is partly true, but the conclusion is entirely wrong. There are several ways in which food production may be assisted by science, among them: (1) increasing the output per acre of land, (2) increasing the output per man-hour of labour, (3) increasing the area of cultivated land. The great development of transport during the past fifty years led to the opening up of new countries, and made the third of these possibilities the easiest; it was consequently adopted. The extension in area of cultivated land has proceeded *pari passu* with the growth of the population, and there are still, as there were fifty years ago, some two acres of cultivated land for each civilised human being. There has been no pressing necessity, and therefore no economic inducement, to increase output per acre.

The great increase in rates of farm wages, however, has compelled an increased output per man-hour of labour, and this has been accomplished. In 1881 on a farm of careful management and careful records it took 117 man-hours to grow one ton of wheat; in 1921 only 82 hours were needed. Equally marked changes have taken place in the root crops.

Further, science has greatly increased the certainty of crop yields: catastrophes are things of the past. In 1844 potato blight came to the British Isles, and for forty years its depredations were almost unchecked. It caused the appalling Irish famine of 1845–46, and between 1877 and 1880 its damage in Ireland alone was estimated at £20,000,000. The committee of inquiry set up in 1880 reported that all witnesses, scientific and practical, believed it to be hopeless to prevent the spread of the disease once it had set in.

All this is changed; an effective fungicide now keeps the disease in bounds so that it is no longer feared.

By common consent the worst season of the last century for the wheat crop was 1879, when the persistent wetness and high rainfall completely baffled the farmers of Great Britain. The financial losses were appalling, and the season was long remembered with dread in the countryside. During the present century there have already been three years of higher rainfall, 1903, 1912, and 1924, than 1879, but there was no agricultural crisis. Of course there were losses, but they did not compare with those of 1879, and they are already almost forgotten.

The statement, frequently made, that yields have not increased, is only partially true. Wheat is commonly taken as the test crop, but this is unfair. It was formerly the most important crop on the farm, but now it is much less important. The high yields of fifty years ago were attained by abundance of cheap labour; to-day this method is not available. New methods have been devised which pay the labourer several times the old wages and which yield at least as much produce per acre. More direct comparison can be made by taking crops in which we have been self-supporting over the whole period and for which therefore the relative importance in the farm economy has not diminished. Precise statistics of average yields are difficult to obtain, but trustworthy experts fifty years ago put the yield of potatoes at about 6½ tons per acre under good farming conditions. Now, however, a good farmer would expect 10 tons per acre, and could reasonably hope for more Similar increases can be recorded for some of the fruit and market garden crops, as well as the important cucumber and tomato crops.

It is freely admitted, of course, that science has not been the only factor at work. The makers of implements, and fertilisers and feeding-stuffs, seedsmen, the country school teacher, and the farmers themselves have all played their part, but it is impossible to deny that science has largely contributed to the result.

Finally, scientific work has demonstrated that this intensification of production is possible for all farm produce. At the present time much of the knowledge remains unused in regard to certain items such as wheat, lower qualities of meat, etc., because the alternative method of increasing the area of cultivated land still remains open and is cheaper. But obviously this will not always be the position, and it is perhaps the crowning achievement of agricultural science that it is steadily working at methods of intensification, knowledge of which will be imperative directly the area of cultivated land has reached its limit.

E J. Russell.

Rothamsted Experimental Station,
Harpenden, Herts.

It was far from my intention to suggest that science, generally, had failed to help in increasing the production of food, and least of all to base such an assertion on official statistics of the average yield of wheat. If Sir John Russell had heard Venn's smashing indictment of official underestimating, delivered last year at Oxford, he would not tilt at that windmill. All I need plead guilty to is extreme sympathy with the view that the value of science is not merely materialistic; but until this sympathy is more universal than it is now, the unenlightened public will not cease to clamour for more spectacular results than agricultural science, in its 'slow and painful' progress, has produced in the last fifty years.

The Reviewer.

The Sleep of Whales.

Very little is known about the sleep of whales. They seldom sleep at the surface. Scoresby, speaking of the Greenland whale, says: "Whales are seldom found sleeping, yet instances occasionally occur, in calm weather, amongst ice." I have in my possession a large number of log-books of whaling voyages to the Greenland Sea and do not find a single example recorded. The recently published log-books of Capt. Scoresby, senior, tell the same tale.

Years ago I made a number of voyages to the Greenland Sea with my father, the late Capt. Gray, of Peterhead. On one occasion when we were amongst the ice, and it was my duty to be in the crow's nest, I discovered, with the aid of a telescope, a dark stationary object in the water a few miles away. It proved to be the 'crown' (*i.e.* the highest part of the head) of a Greenland whale asleep. It was on the far side of a large field of ice, and as the wind was light, our ship was two or three hours in reaching it. When we came to it we lowered two boats, one of which pulled towards it and harpooned it.

A few years later we again came across a Greenland whale asleep. This time our ship was anchored to a large floe; the whale was again sighted from the crow's nest, and it fell to my lot to attack it. Pulling for a few miles along the edge of the floe, we came in sight of the sleeping whale. We approached it from behind, as quietly as possible, and before firing the harpoon gun I allowed the boat to run towards it until the bow was over its tail and the stem was almost touching its back. Before the whale left the surface I saw that the harpoon was buried in its back.

I had an excellent opportunity of seeing both these whales. In both cases they lay motionless at the surface from the time they were first sighted until attacked. In both, the 'crown' on which the blow-holes are situated was out of the water, and the back slightly so or awash. Neither of them appeared to be breathing and neither gave any signs of life until harpooned. Their slumber appeared to be very profound.

I remember being told that sleeping whales when suddenly awakened by the harpoon sometimes beat the water with their fins and tail, instead of immediately leaving the surface. For this reason, in the case of a sleeping whale, the attacking boat ran some risk, and in the days of the hand harpoon, when it was necessary to approach very close to the whale, it was usual to awaken it first by tapping on the wood-work of the boat. No harm resulted to the attacking boats in the above instances, but I should have mentioned that the first whale was awakened (but fortunately not alarmed) by a slight ripple that proceeded from the ship's bow before the boat reached it, and that the other did strike the water once violently with its tail but without harming the boat.

It was also my good fortune one voyage to see and harpoon a narwhal asleep, but as the incident is described in the *Zoologist*, 1889, page 100, there is no need to refer to it at length here. As in the Greenland whale, the narwhal when asleep lies motionless at the surface and gives no sign of life. Although these small whales are common amongst the ice, and although it was my duty to spend much time in the crow's nest, I do not remember seeing another asleep on any of my other voyages.

If whales seldom sleep at the surface, where do they usually do so?

The Greenland whalers believed that the Greenland whales sleep under the ice, and that they retired under it at regular intervals for the purpose. Scoresby Senior was of this opinion, and even sent his men on to the ice to awaken them. His celebrated son, a very cautious writer, contents himself with stating: "Some persons are of opinion that whales [*i.e.* Greenland whales] can remain at the bottom of the sea in shallow water, when undisturbed, for hours at a time." According to my father, who had a life-long experience and had opportunities of watching sleeping whales, "the Greenland whale does not require to breathe while asleep and does not do so" (Seventh Annual Report of Scottish Fishery Board, part 3, p. 367).

How are the foregoing observations to be reconciled with what is known of the physiology of whales? What is the explanation?

It is obvious that sleep is as essential to whales as to other animals; that the access of water to the lungs must be guarded against at all costs, and that there is a limit to the time they can live without air. It is also obvious that if whales can remain under water for an hour or more when harpooned and exerting themselves to escape, they can do so for very much longer when their voluntary muscles are at rest. I venture to suggest that whales when asleep awaken to breathe at intervals; that after breathing they relapse into a profound slumber; that the blow-holes are tightly closed during sleep (as indeed appeared to be the case) so as to make it impossible for water to enter the respiratory passages, and that they (the blow-holes) are not necessarily or even usually above water during sleep; that whales usually sleep below the surface hidden from observation and undisturbed by wave motion, but that they rise to the surface at intervals to breathe. In what other way can the facts be explained? I am not prepared to say how long the Greenland whale can sleep without breathing, but it certainly appears to be a long time from what I saw.

I have to add by way of a postscript that we sometimes came across quantities of stringy mucous floating on the surface of the water amongst the ice. According to my father, who called them 'blowings,' they are discharged from the blow-holes of whales, but whether they consist of mucous that accumulates during sleep and is discharged when they awake or is merely evidence of a catarrhal condition, I am unable to state. Robert W. Gray.

11 Hulham Road,
Exmouth, Devon.

Florentium or Illinium?

In a recent issue of Nature (Feb. 26), and also in *Science*, Prof. W. A. Noyes writes claiming priority for the discovery of the element No. 61 for the American chemists, Messrs. Harris, Hopkins, and Yntema. As an argument in favour of this priority two papers are quoted: one by C. C. Kiess (U.S. Bureau of Standards, 442; 1922; 446; 1923), and the second one by L. F. Yntema, which appeared in 1922 and 1923 respectively.

The first author has accurately studied the arc-spectra of neodymium and samarium, using pure materials supplied by Prof. Hopkins of the University of Illinois. During this research C. C. Kiess found many lines in the visible spectrum common both to neodymium and samarium and of unknown origin. He considers the possibility of these lines belonging to a new element and, following Moseley's rule, since a new element of atomic number 61 should occur between neodymium and samarium, Kiess infers the new element to be No. 61. L. F. Yntema (*Jour. Amer. Chem. Soc.*, 46, 37; 1924) examined the spectra of the same material in the ultra-violet, and he too found five lines not yet classified. Considering then the possibility that these lines could belong to a new element of atomic number 61, he made an X-ray investigation of the *K*-absorption spectra, using de Broglie's method, as well as of the *L*-emission spectra: in both cases he had a completely negative result. The conclusion of Yntema's paper may be quoted: "X-ray analysis of samples from different sources has so far given no evidence of the presence of this element."

In the study of emission spectra in the visible and in the ultra-violet, it is not sufficient evidence for assuming the existence of a new element, to have found lines common both to neodymium and samarium and yet unknown, because the emission spectra of these elements are extremely complicated and uncertain, and also because it is not easy to be perfectly sure about the spectroscopic purity of the material used. These have been the chief reasons why for many years, before Moseley's discovery of the possible number of elements, it was believed that new elements had been discovered only from the fact of having seen new spectral lines. Some of these elements have been really found afterwards, but in this case the discovery did not belong only to those who had noticed the spectral anomalies; the non-existence of other of these supposed elements was proved on further examination.

Indeed, about the homogeneity of the elements composing the old didymium there have been for many years numerous discussions after Auer v. Welsbach succeeded, in 1885, in separating neodymium from praseodymium; many experimenters tried to show the heterogeneity of the new elements. In 1886, Crookes (*Proc. Roy. Soc.*, 40, 502; 1886) affirms that the two didymia are complex, and so too Demarçay (*C. R. Acad. Sci.*, 102, 1551; 1886; 105, 276; 1887), Becquerel (*C. R. Acad. Sci.*, 104, 777; 1887; 104, 1691; 1887), G. M. Tomson (*Chem. News*, 55, 227; 1887), Ksewetter (*Ber. Chem. Ges.*, 21, 2310; 1888). Crookes and many others, starting from the anomalous behaviour of emission and absorption spectra, believed that didymium should contain at least one other new element. Krüss and Nilson (*Ber. Chem. Ges.*, 20, 2134; 1887) even stated that didymium and praseodymium were composed of at least nine elements.

In 1913, Moseley's rule removed any uncertainty from these researches, establishing that one and one element only ought really to be found in the didymia earths, and that to this element belonged the ordinal number 61. The merit for this improved prediction should be credited only to Moseley, who defined and circumscribed the field of research.

We believe, then, that the priority in the discovery of element No. 61 belongs instead to those who first had sure data as to its existence, and in similar cases sure evidence cannot be obtained except by means of X-ray investigations. While L. F. Yntema published the negative results of his research in this field, we obtained (X-ray measurements were made by Prof. R. Brunetti) the first photographs of *K*-absorption spectra showing the characteristic band of element 61 and, a few months after, we collected our results in two papers deposited, as *plico suggellato*, at the Accademia dei Lincei. These contained the first certain data, therefore we believe that we should be credited with priority for the discovery.

As regards Prof. Noyes' remark upon the priority of name, we would point out that the name Florentium was given by us in June 1924, a year and eight months before the paper referring to the name Illinium appeared. We are, on the other hand, perfectly in agreement with Prof. Noyes that much additional work has still to be done on the subject, and we hope that the combined effort of researches will, in a short time, bring about the undisputed acceptance of the new element.

L. Rolla.
L. Fernandes.

R. Università Firenze,
Via Gino Capponi, No. 3.
Mar. 21.

Transmission of Stimuli in Plants.

For two writers living in the East to carry on a correspondence in the columns of Nature is a somewhat protracted process, but perhaps I may be permitted to reply to the remarks of Sir J. C. Bose (Nature, Jan. 8) regarding a previous letter of mine (Nature, Oct. 23, 1926).

It is interesting to note that Sir J. C. Bose now apparently accepts the fact, originally demonstrated by Dr. Ricca, that in Mimosa the excitation induced by a flame can be transmitted across a water-gap.

The importance of this fundamental experiment is quite unaffected by any amount of experimental evidence which may appear to show that the phenomena associated with the transmission of stimuli are closely similar in the plant and in the animal. It is not really essential to show that the excitation induced by every kind of stimulus can similarly be transmitted across a water-gap, although, provided that the stimulus can be made sufficiently intense, there should not be any difficulty in affording the necessary proof. It must be remembered, however, that if only a small amount of hormone is set free, it would suffer so much dilution in passing through the water-gap that its stimulating power would be seriously diminished.

Some of the arguments used by Sir J. C. Bose against the transpiration current theory have little force. For example, he states that the impulse should only travel upwards in the same direction as the ascent of sap. Movement in either direction is readily explained by the generally accepted theory of the ascent of sap put forward by Dixon and Joly, and can easily be demonstrated by cutting the plant under stain. At the same time it must be admitted that, although Dr. Ricca's theory undoubtedly explains many of the normal instances of conduction in Mimosa, it does not afford a complete explanation in every case. In submerged shoots, for example, where the transpiration current is almost negligible, stimuli may be conducted through long distances in the stem at a rate of more than 200 cm. per minute. In a paper which I hope will be published early this year, I have suggested that in such cases the transport of the stimulus takes place as a result of the contraction of highly turgid cells. At the point where the stimulus is applied, certain of the cells contract and liberate a stimulating substance. This affects neighbouring cells, which in turn liberate more of this substance, and so the process goes on. For the experimental evidence on which this theory is based, I must refer Sir J. C. Bose to the complete paper, but I may mention that it appears to afford an explanation for those cases where, as already pointed out by Mr. R. Snow, the transpiration current theory is inadequate.

The evidence which Sir J. C. Bose has brought forward in favour of his own theory is well known and is extremely interesting. Even if one holds the view that the conduction of stimuli in Mimosa takes place apart from any nervous mechanism, it is still necessary to consider certain of the phenomena associated with electrical stimulation. It seems probable that these may be explained in other ways, although, at the present state of our knowledge of the factors involved, this may be difficult. If, however, it is finally proved that there are certain facts which cannot be explained by any other hypothesis, then, and then only, shall we be justified in accepting a nervous mechanism as *one* of the methods by which stimuli are transmitted in plants.

Nigel G. Ball.

University College, Colombo,
Feb. 3.

River Pollution and the Acidity of Natural Waters.

In "Fundamental Problems relating to River Pollution" (Nature, Mar. 26, p. 463), Mr. H. W. Harvey mentions the probable effect of the hydrogen ion concentration on river flora and fauna, and suggests that possibly pH 5·5 is a critical value.

It seems probable that, as regards fish life, acclimation may be an important factor and that possibly fish habituated to acid conditions may readily tolerate a degree of acidity which would be very deleterious, if not fatal, to others reared in, and accustomed to, neutral and alkaline water. The burns and lochs of the Scottish highlands are largely in peat and igneous rock; limestone exists only in small areas and in isolated districts. The water supply coming from peat is essentially acid in character, and in surface drains and pools the *p*H value may be no more than 3 or 4; clear springs coming through the 'pan' under the peat have been found to be *p*H 4·5, while in a peat surrounded loch of the same water value trout, averaging ¾ lb. in weight, flourished. Both trout and salmon will leave a burn having water of *p*H 6 for another and smaller of *p*H 5 in order to spawn. In similar peat districts with a limestone formation, however, the acidity is lessened or neutralised and the burns vary from *p*H 6 to *p*H 7·5.

Such acid conditions as prevail in the typical peat district may perhaps affect the nature of the flora and may possibly restrict the fauna, but both trout and salmon parr can, and undoubtedly do, thrive in water of *p*H 4·5 to *p*H 6. W. J. M. Menzies.

Fishery Board for Scotland,
Edinburgh, Mar. 30.

A Useful Electric Cell.

Take a glass vessel, a porous cell, a zinc rod and a carbon plate, such as are used in the ordinary Leclanché cell (a circular glass vessel of the same capacity is better). Prepare a solution of 20·4 grams of potassium dichromate and 87·4 grams of sulphuric acid (sp. gr. 1·75) in 350 grams of water and pour it into the glass vessel. Place the carbon plate in this solution. Fill the porous cell with a solution of 14·5 gm. of ammonium chloride in 200 gm. of water and place it in the glass vessel containing the dichromate solution. The amalgamated zinc rod is placed in the porous cell. The E.M.F. of this cell is 2 volts. The internal resistance is about 0·6 to 0·8 ohm. When continuously used, it gives a constant current for more than 12 hours, and the E.M.F. remains unchanged. The rate of dissolution of zinc (when a rod of zinc is used) is only 2·5 gm. in 12 hours, while in the bichromate cell the rate is 12 gm. When used intermittently, the cell remains efficient for more than three weeks. S. L. Jindal.

D.A.V. College Laboratory,
Cawnpore, Feb. 24.

Biological Fact and Theory.

Prof. Walker in Nature of Mar. 26, p. 456, introduces personalities into his reply to my letter. In the circumstances, I do not wish to continue a discussion intended to deal with the purely scientific issue of whether Prof. Nöel Paton's attack on accepted genetic theory was justified.

I would, however, like to repeat the statement with which I began, namely, that the progress of biology in Great Britain is being retarded by the failure of specialists in its various branches to appreciate the bearings of work done in other fields than their own. With regard to the specific point at issue, Prof. Walker writes that he has watched "often with amazement, sometimes with amusement," the attempts of geneticists "to make the 'neo-Mendelian' 'laws' agree with the results of breeding experiments." What must a physicist think of biology and biological theory when he reads this? In physics, at least, the prime aim of the man of science is to make his theories fit the facts of Nature. One's comfort is that, with few and negligible exceptions, the whole body of those engaged upon genetical research are actually employing the conceptions and theories which I enumerated, and which Profs. Paton and Walker repudiate, as a means to the discovery of new and fruitful facts. Julian S. Huxley.

King's College, Strand,
London, W.C.2.

The Development of Natural History Museums.

Opening Nature of April 16 at p. 551, I am astounded to read: "What has the Natural History Museum . . . done to make Darwin's . . . discoveries current amongst his own people? . . . Nothing! Except for a few isolated exhibits, shown almost in holes and corners. . . ."

When you favour this Museum with a visit you will doubtless observe the statue of Darwin in the place of honour, looking down on a Hall in which are conspicuous cases illustrating such subjects as variation under domestication and in Nature, protective coloration, mimicry, intergradations between species—cases which, I may remark, set an example to the world.

If you will then do me the honour to enter the Geological Department, the very first label (a large one, next the door) you will find explains evolution in Proboscidea, while the relevant specimens face you on entry. If you will kindly follow me into Gallery VIII you will speedily be brought up by an exhibit in a large central case elucidating evolution, convergence, and adaptation in some stalked echinoderms; farther on is one illustrating evolution in the sea-urchin Micraster. The cases devoted to Polyzoa illustrate growth and evolution in a colonial organism. Returning, you cannot miss the classical instances of the Steinheim Planorbis, the Viviparus of Slavonia, and the Melanopsis of Hungary.

You could see more examples in other galleries, but that is enough for one visit. Let me, however, remind you that similar exhibits prepared and arranged by the staff of the Museum have been shown at the White City and at Wembley in several years. Guides to the Geological Department have been praised for their connecting thread of evolutionary philosophy. Towards that philosophy of recent years one of the most important contributions has been the catalogue of fossil Polyzoa, notably the volumes by Dr. Lang.

With much that you say I am in hearty agreement. But if you wish for reforms you will not get them if you begin by antagonising those who are working all day and every day to put those reforms into actual practice. Let me assure you that the combination of accuracy and order with imagination and breadth of view is not impossible, even in a museum official: certainly it should not be impossible in a leading article of our chief scientific paper. F. A. Bather.

Natural History Museum.

Dr. Bather's comments surely support our plea for a more educative and effective arrangement of exhibits of fundamental biological importance. Under his skilled guidance several such exhibits may be discovered, but to the ordinary intelligent visitor, who may lack such guidance, they are for the most part lost in the systematic arrangements to which they are subordinated, and if discovered can make only an isolated and non-cumulative appeal. Our comments, however, were not meant as hostile criticism, for probably as much has been accomplished as the conditions allow; we endeavoured to indicate that, under present conditions, it is difficult or impossible to keep the exhibits abreast of the modern scientific and educational outlook, and that this, with other factors, pointed to the desirability of an inquiry into the position as a whole.

The Writer of the Article.

Proposed Review of the Mineral Resources of the British Empire.[1]

By Sir Thomas H. Holland, K.C.S.I., K.C.I.E., F.R.S.

In general terms the mineral production and metallurgical activities of the British Empire are already known; but no one has measured a base-line with sufficient precision for projecting with confidence the probable effects of further prospecting and future exploitation, coincident with the growth of metallurgical science, not only on the Empire as a whole, but also on each independent unit of Imperial territory.

War stresses demonstrated that the Empire is in reality a *political* unit, and, because of the strength and efficiency of the navy, its resources were then worked successfully as a *military* unit. But we all know that it is still far from being an *economic* unit, and it is conceivable that military developments in the near future may make it difficult, perhaps impossible, for the mineral resources of all parts to be assembled for any purpose.

Great Britain is at present the chief manufacturing section of the Empire, and it consequently will remain for many years to come the principal arsenal and base for stores of most sorts. In order to be precise regarding the mineral supplies that can be relied on in any contingency, it is necessary to have exact details regarding the resources of each isolated unit of territory; for there are many essential munitions—animal and vegetable as well as mineral—that Great Britain itself cannot supply, either in the right kind or in the requisite quantity.

In mentioning military requirements, I do not refer to munitions in the narrow popular sense as lethal munitions. They form only a fraction of the supplies that are essential to an army in the field. What a soldier wants on active service under modern conditions may differ largely in form, but agrees very nearly in substance, with what he wants during ordinary peace-time civilised life; and whilst the A1 extract of young men is in the field, the larger insoluble residue of the population insists on its accustomed food, clothing, business, and amusements at home. The maintenance of the *morale* of a modern civilised community requires of raw materials and manufactured products the same kind that is necessary for the fighting army, but in a much larger quantity.

Thus, the economic and military problems of supply are not very different in nature: the fighting strength of a nation is limited by its industrial strength, and its industrial existence depends on the maintenance of a sufficient supply of raw materials.

There are, however, some raw materials that a country, for commercial reasons, often neglects under normal industrial conditions: its requirements of the articles manufactured from such materials can be obtained from other countries ordinarily in circumstances so favourable that the local establishment of manufacture may not be worth while commercially. For example, before the War, the wolfram deposits in South Burma were worked mainly by British companies, but practically the whole of the mineral went to Germany for the manufacture of tungsten; and then, although Sheffield occupied about the front place among manufacturers of high-speed tool-steel, its tungsten was obtained from Germany. Attempts made before the War to smelt tungsten in Great Britain had not been commercially successful; and at the time, that seemed to be a small matter, for we readily obtained all the tungsten we wanted from Germany, and Germany obtained all the ore she wanted from British territory. With the War, however, two inconveniences followed in order. First, we had to devise our own plant for smelting tungsten, and, under compulsion of necessity, we succeeded before the middle of 1915. Second, Germany found herself without tungsten ore, and that proved naturally to be more serious; for, although she obtained some molybdenum from Norway as a substitute, it was not exactly the same thing; and even this new move was countered by British purchases of the Norwegian output of molybdic ores.

Three lessons can be stated at once from this example:

(1) Whilst the military authorities of Britain may rely on our ordinary industrial complex for nine-tenths of their requirements, it is their business to see that the essential tenth is secured, and they cannot identify that tenth unless we provide full information regarding our resources.

(2) It is *important* to be sure that we can smelt as well as mine an essential ore; technical progress in mining and metallurgy in Great Britain must keep pace with the prospective developments of other nations.

(3) It is absolutely *essential* to be sure that we can get access to supplies of the necessary ores.

Germany rushed into a war that she expected to be over in a few months; she made the mistake of thinking she had sufficient reserves of tungsten ore. We made no mistake in that direction; for apparently the British General Staff did not think at all of a matter so small. Between 1911, when war was seriously threatened, and 1914, when it became unavoidable, efforts were devoted with conspicuous success to the training of an army that gave a new meaning to the word 'contemptible'; but who thought it necessary to provide for the smelting of an inconspicuous metal like tungsten, either in Britain or in British territory?

I have quoted the recent War conditions as the basis for our lesson, because the results were sharp and demonstrable, as well as still fresh in our memories. The way in which Germany was embarrassed by the blockade is a warning of what may happen if, by more effective means for cutting communications in the future, Britain becomes isolated, or, more likely, one of the outlying Dominions becomes blockaded in a future war.

Great Britain is so obviously unable to provide many essential raw materials in sufficient quantities, even under peace conditions, that to show by a detailed survey that she may be short of another mineral or two will not add much to the responsibility; but it is important to make estimates of the resources of each Dominion, and, separately, for groups of them and the Colonies—the minerals that each can mine and smelt, the ways in which each can supply the needs of others, the kinds that each can draw from adjoining foreign territory, and the amounts of the smaller, but necessary, mineral products that each should accumulate as stocks to draw on in a temporary emergency. Most nations carry stocks of gold and some of silver, but why not antimony, nickel, tungsten, and quicksilver as well? If isolated, could any Dominion, except Australia, meet its requirements in antimony? Could any country, except Canada, provide enough nickel? Could any part of the British Empire raise its own mercury? Yet, it would be less expensive to accumulate stocks of these sufficient for a few years' requirements than to buy a battleship; for a battleship is expensive to maintain, it gets quickly out-of-date, and it would be of little use in any event without supplies of most of these metals. Stocks of some metals are desirable also from the economic point of view, as they can be used to prevent speculative changes in prices.

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[1] From a paper read on April 21 before the Institution of Mining and Metallurgy.

Production figures give us a partial idea of resources; but something far more complete than this is necessary in devising a fiscal policy within the Empire itself, and *vis-à-vis* the rest of the world. The major mineral products are naturally those of most public concern from the economic point of view, but what we regard as minor and accessory minerals in times of peace may become vitally, or, more correctly, fatally, important under conditions of war.

Statistics of current production form an essential basis on which to design an economic policy, but they are unsatisfying in two important respects: (1) They do not reveal a country's resources in those minerals that could be exploited if and when necessary, but are not now worked under those commercial conditions that have developed by existing fiscal regulations; and (2) they do not give us an idea of the reserves available for future exploitation.

No other country has been more thorough than the United States in accumulating and publishing figures for production. Yet, in spite of these advantages, the international, and consequently political, aspects of mining and metallurgy, which arose directly from war and post-war conditions, remained to a certain extent neglected. In 1921 the Mining and Metallurgical Society of America combined with the American Institute of Mining and Metallurgical Engineers to establish a joint committee, under the chairmanship of Prof. C. K. Leith, to survey the problems of industrial preparedness in the United States; and this Committee on Foreign and Domestic Mining Policy first established a series of propositions, to be tested by a special sub-committee, for each important mineral.

The propositions[2] adopted by the Committee are summarised as follows:

(1) The international movements of certain minerals are inevitable, and although they may be hindered by fiscal barriers, they cannot under civilised conditions be stopped altogether. It is thus considered to be foolish to attempt by artificial restrictions to make any country self-contained: each should be allowed to benefit by drawing on the special advantages of others.

(2) Thus, in order to reduce transport expenses, concentration generally, followed according to circumstances by smelting or fabrication, should be accomplished near the source of supply.

(3) Prof. Leith and his colleagues plead for freedom for all nationals to prospect and exploit, and they urge that laws granting concessions should require that licensees of prospecting rights over large areas should be compelled, within reasonably short time, to narrow their claims for mining leases to areas that can be exploited effectively.

(4) Pressure on backward governments may be necessary to prevent them from shutting out those who are willing and able to develop mineral resources, of which they have surplus supplies, whilst industrial countries are suffering from deficiency; but any government using such pressure should observe the principle of the open door for all nationals.

(5) Government—that is, the United States Government—should improve the official intelligence agencies in foreign lands and so assist Americans with the information and help necessary for mineral enterprise abroad. There should be more attempts to obtain and correlate information regarding the world's resources in important minerals.

(6) The committee classified the known mineral deposits of the United States into:

(*a*) those that are obviously in quantities large enough to spare a surplus for export;

(*b*) those that just meet domestic needs, without excess or deficiency;

(*c*) those that exist in noticeably inadequate amounts; and

(*d*) those that the United States lack almost entirely.

The American assumption that we have nearly full knowledge of the distribution of mineral deposits of importance may be approximately accurate for the United States, but it would be unwise to apply it to Canada, to our African colonies, or to Australia. Possibly new discoveries in these areas will not disturb the world's supply of coal, manganese, iron ore, or petroleum in the near future, but it would be unwise to add copper and other relatively cheap base metals; in any of these partially explored areas there may well be deposits large enough and rich enough seriously to divert the present streams of the metal trade. Even the new discoveries of manganese on the Gold Coast threaten to change the source of supply of these ores.

However, it is useless to investigate our resources in minerals, and futile to discuss schemes to secure local smelting and refining, if the laws which control the grant of concessions for prospecting and mining add unduly to the cost of exploitation.

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[2] "International Control of Minerals," New York, 1925, p. 7.

The conditions for mining change with the increase of transport facilities, with the development of new local markets, and with the growth generally of industries and technical science. Facilities of the kind that are necessary to encourage enterprise should thus be reviewed at reasonable intervals. No rules can hold good for longer than a few years, but their revision at frequent intervals tends to unsettle the confidence of business men, which of all bad policies is the worst.

It is the business of a mining company to make as much profit as possible out of a mineral deposit during the period of its mining lease; it is the business of government to safeguard a national asset of vital importance which cannot be replaced or renewed. But it is better for a country that its mineral deposits should be worked than that they should be left lying idle. The mineral policy of a government is thus the choice of a judicious mean between extravagance and conservatism; and, as the values of minerals vary with the industrial development of a country and that of the countries with which it is in trade communication, this judicious mean will gradually shift its position between the two extremes. Thus, the whole problem of framing and working a mineral policy for a large State is a choice of the judicious mean in all things—rents, royalties, periods of tenure, and size of areas leased.

There is a fundamental difference between State ownership of mineral rights and State ownership of mines, but there is a prevalent tendency, and therefore danger, of lumping both together as similar forms of Socialism, thus bringing them both into the arena of party politics. Legal doubts about security of tenure, absence of clear title to surface rights, local variations in length of lease and rate of royalty, the independent necessity of acquiring wayleaves and water-rights, are frequent accompaniments of the private ownership of minerals, and they all adversely influence the financier who is asked to underwrite a mining enterprise in an area in which he is not otherwise interested. The end effect of these disadvantages is a handicap to the enterprise, which, like every other item of cost in mining, results in a loss to the State of some part of its mineral reserves.

The mining industry differs fundamentally from others: mineral deposits cannot be transplanted from one country to another; no nation, not even the British Empire, and much less any Dominion, is self-contained; minerals are essential for the maintenance of our commercial life and for military security; yet they can be worked once, and once only, in the history of a nation; the necessity for exchanging minerals between the Dominions involves the question of their fiscal interrelations; the necessity of exchange with other nations affects our foreign relationships. The importance of being safeguarded in mineral resources is only in a degree greater than the importance of being able to smelt our own ores.

There are good reasons, therefore, for classing mining with most of the public utility services, that is, as an industry that might be safeguarded by State action, without the intervention of party politicians or fear of doctrinaire Socialism.

Official and State-aided organisations already exist for the collection and publication of mineral statistics, but institutions of the sort, in order to retain the public trust in them for reference purposes, properly avoid the discussion of those conditions that affect finance and therefore the progress of exploitation. There are so many phases of the two complementary industries of mining and metallurgy which require a wide range of specialists for judicial consideration, that the task of making a survey of our mineral economics might be safely entrusted to those institutions at home and in the Dominions Overseas that have joined in organising the Empire Mining and Metallurgical Congress and Council. It is suggested that these institutions be invited forthwith to inaugurate special surveys for their appropriate territorial units, each being left to follow the plan that appears to it most suitable to the special conditions of its own Dominion and State.

The National Museum of Wales.

The formal opening, by their Majesties the King and Queen, of the National Museum of Wales, took place at Cardiff on April 21, at a ceremony characterised by great dignity and splendour. Fifteen years ago their Majesties laid the foundation-stone of the building, and, in fulfilment of a hope expressed on that occasion, they graciously consented to open the first portion of the institution to be completed. Representatives from all parts of the Principality, embracing every side of the national life and thought of Wales, were present, while Mr. C. Tate Regan, Director of the British Museum (Natural History), and Mr. J. Charlton Deas, President of the Museums Association, represented the national and public museums of Great Britain.

Their Majesties were met on their arrival by Lord Kenyon, President of the National Museum of Wales, Lord Pontypridd, Lord Mostyn, Lord Treowen, Lord Aberdare, Sir William Reardon Smith, the Treasurer of the Museum, and Dr. Cyril Fox, the Director. Mr. Dunbar Smith, the architect of the building, was presented to the King and asked His Majesty's acceptance of a mallet with which to perform the ceremony. Their Majesties then proceeded to the Entrance Hall of the building where the main ceremony took place. A loyal address on behalf of the Court of Governors and of the Council of the National Museum was read by Lord Kenyon and replied to by the King, after which the members of the Council of the Museum were presented to their Majesties. In the course of his reply to the address the King paid a well-merited tribute to the high ideals and achievements of the Museum, to the liberality of its benefactors, and to the wise planning and skilful designing of the building. He spoke of the valuable help the Museum could render by cultirating in the Welsh people a sense of beauty, a love of national scenery, and a pride in their nation's historic past, and by kindling a spirit of loyal service to its future welfare.

Under the guidance of the President and Director of the Museum, the King and Queen then made a tour of inspection of the building, in the course of which the King unveiled three tablets naming the Lord Glanely Gallery, the Pyke-Thompson Gallery, and the Reardon Smith Gallery, commemorating the principal benefactors.

Before and during the ceremony a delightful programme of music, under the direction of Sir Walford Davies, Mr. Warwick Braithwaite, and Mr. W. M. Williams, was given by a mixed choir of 300 voices drawn from choral societies all over Wales, the Cardiff Musical Society, the Romilly Choir, and the Cardiff Orchestra of the British Broadcasting Corporation. The occasion was a most auspicious one for this great Institution and a fitting inauguration for work of such first importance as that which it is seeking to do.

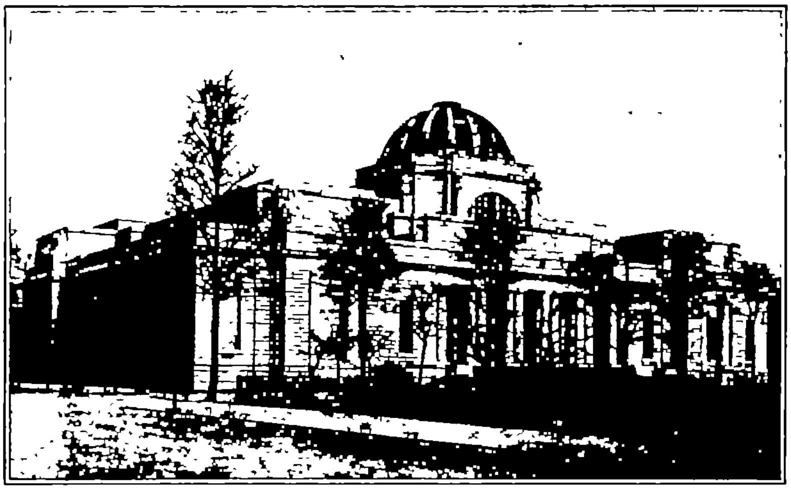

FIG 1.—National Museum of Wales, Cardiff. Front view.

The idea of a National Museum for Wales was born more than thirty years ago, but the practical commencement of the scheme may be said to date back to 1903, when a resolution approving the scheme was moved in the House of Commons by the late Mr. William Jones, seconded by Mr. (now the Right Hon. Sir) J. Herbert Lewis and supported by Sir Alfred Thomas (now Lord Pontypridd). In 1905 a Special Committee of the Privy Council decided upon Cardiff as the most fitting locality for the Museum, and the Cardiff City Council allocated the magnificent site of five acres in Cathays Park on which the building is now in process of erection. The then existing Corporation Museum in Cardiff formed the nucleus of the national collection.

The Royal Charter establishing the Museum was granted in 1907, and in 1908 the first Director, the late Dr. W. Evans Hoyle, was appointed to the post. With characteristic energy, Dr. Hoyle threw himself into the work of preparing details of the requirements for the proposed building, and in 1910, after open competition, the design of Messrs. Smith and Brewer was accepted out of 130 competitors. The foundations of the south front and parts of the east and west wings were commenced in 1911 and the foundation-stone was laid by the King and Queen in 1912. The War, unfortunately, necessitated the complete suspension of building operations when only about one-half of the superstructure was completed, and the adverse conditions of post-War years, with the increased cost of building which accompanied them, has delayed the completion of these first portions of the Museum until this year. Even now it has been possible to do so only through the magnificent gift of £21,000 from Sir William Reardon Smith, the Treasurer of the Museum, which enabled the Museum authorities to appeal to the people of Wales for funds to complete the superstructure commenced fifteen years ago.

The National Museum of Wales is one of the best-designed Museum buildings in existence. The wide knowledge of museum construction and requirements possessed by its first Director, together with the skill of a most understanding architect, have combined to produce a building of great beauty, strikingly individual in character, yet dignified and nobly proportioned, in which both exhibition galleries and workrooms have been successfully planned on the lines of the most modern ideas of museum construction.

The entrance hall, the scene of Thursday's historic ceremony, is one of the chief glories of the building. It consists of a central octagon roofed by a lofty dome, with lateral bays extending the full width of the south front. The beauty of its great interior is of simple character arising out of structural necessities, fine proportions, adequate and well-placed lighting, and sound, beautiful craftsmanship.

The building opened by the King and Queen last Thursday represents little more than a quarter of the contemplated scheme. In it, however, separate galleries are available for zoology, botany, geology, archæology, oil paintings, water colours and prints, while the lateral bays off the entrance hall are to be devoted to sculpture, so that it is possible to lay down the general lines on which all sections of the institution will be developed.

The completion of this first portion has already had a stimulating effect. Lord Buckland has made a donation of £35,000, and Mr. Lewis

Lougher, M.P., one of £5000 towards the building fund, and, as these donations will be augmented by equal grants from the Treasury, it is hoped to make an early start with a further portion of the east wing, which will include a much-needed lecture theatre.

The purpose of the Museum has been aptly stated in the phrase, "To teach the world about Wales and the Welsh people about their own Fatherland," and it seeks to fulfil this purpose in a large variety of widely spread activities. In the first place, it is actively engaged in the collection and preservation of all kinds of material bearing upon the archæology, art, history, and natural history of the Principality, and presenting to the public a selected series of objects from this material in readily intelligible and attractive form, from which the story of the country in all its aspects can be studied. Secondly, it is doing a great deal of valuable educational work by means of lectures and demonstrations to schools, colleges, societies, and institutions of all kinds throughout Wales, and by an organised system of loan collections, which are sent out to all parts of the country, especially to national organisations such as the Royal Eisteddfod and the Royal Agricultural shows. It encourages and works in close co-operation with local museums in all parts of Wales and helps them by means of loans and curatorial assistance. Through the medium of its printed guides and other publications, information regarding the contents of the Museum in the light of recent research is provided in convenient, popular, and strictly scientific form. It is a valuable adjunct to the University of Wales, especially t the University College of Cardiff, the students o which make regular and frequent use of its resources in the prosecution of studies covered b its activities. Lastly, it is itself a research institution, and most valuable work has been don by the staff. Reference need only be made to th important excavations undertaken at Caerleon Caerwent, and other important archæologica centres in Wales under the auspices of the Museum to realise tha this important aspect o Museum worl has been give a conspicuou place in it policy. Equall important though perhap less well known research ha been accomplished on th natural scienc side.

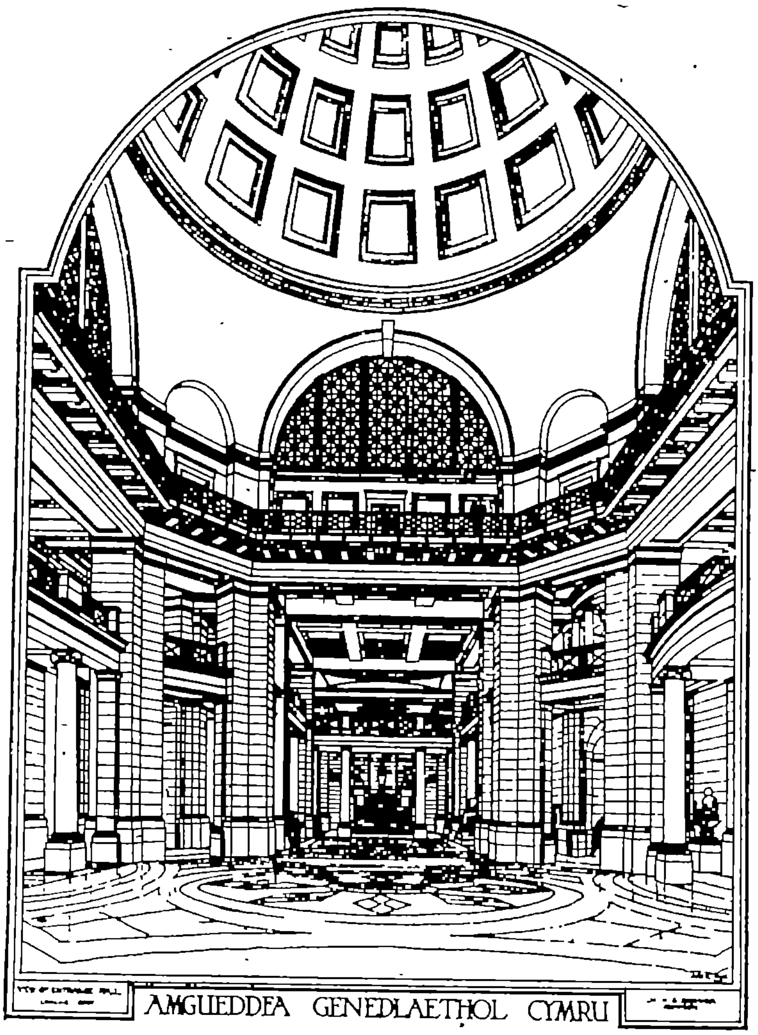

Fig. 1.—Entrance Hall of National Museum of Wales.

The Museum of Wales owe much to it first director Dr. W. Evans Hoyle. It was he who conceived the broad lines of general policy on which the work of the Museum is based, and it is to his ripe experience of museum matters that the success of the institution as a museum must be attributed. His successors in office, Dr. R. E. Mortimer Wheeler and Dr. C. Fox, have continued the tradition established by him. Under direction so able and with purpose so lofty, the success of the museum as a national institution, reflecting national life, ideals, and thought, is assured.

It is to be hoped that the stimulus of last Thursday's ceremony will result in the speedy completion of the whole building, so that the work of the Museum may go forward unhampered and unimpaired for want of adequate accommodation and facilities.

Obituary.

Prof. C. S. Sargent.

FOR more than half a century the name of Prof. Charles Sprague Sargent, Director of the Arnold Arboretum, Harvard University, has been amiliar to all who have interested themselves in the scientific cultivation of trees, and we learn with deep regret that he died on Mar. 22 at his home at Brookline, Jamaica Plain, near Boston, Massachusetts.

Prof. Sargent was a descendant of an old Gloucestershire family and he was born at Boston on April 24, 1841. After graduating at Harvard n 1862, he spent three years in the Federal Army, retiring with the rank of brevet major in 1865. He then spent several years in European travel, and afterwards settled down to botanical study at Harvard, devoting his time very largely to the study of the native trees and shrubs of North America. In 1872 he was appointed Director of the Arnold Arboretum, which was at that time in course of formation in connexion with Harvard University. He was connected with that institution until the day of his death, and it was entirely due to his personality, knowledge, energy, and liberality that the Arnold Arboretum attained the proud position it holds in the scientific world to-day.

In addition to forming a very complete collection of trees and shrubs hardy in this particular locality, Prof. Sargent wrote or edited numerous works on trees and shrubs. His "Silva of North America," published between 1891 and 1902, in fourteen quarto volumes, is a monumental work, and will long remain the standard work on North American trees. His connexion with botanical exploration in China and Japan is well known to dendrologists. In 1892 he undertook a prolonged journey in Japan in order to study the native trees, and the result of his observations became known when he published his "Forest Flora of Japan" in 1894. He afterwards took a prominent part in the organisation of several of Mr. E. H. Wilson's journeys of botanical exploration to China, Japan, and other countries, and he edited "Plantæ Wilsonianæ," an enumeration of the woody plants collected by Wilson in China during his two previous expeditions, which was published in 1913. In addition to purely botanical knowledge Prof. Sargent also possessed a thorough understanding of the cultural requirements of trees and their disposal for landscape effect. He was always ready to impart his knowledge, and was particularly generous in the distribution of plants to other institutions and individuals in his own and foreign countries.

Prof. Sargent was a constant correspondent with the Royal Botanic Gardens, Kew, and was always ready and anxious to share with Kew any of the interesting plants which were collected through the agency of the Arnold Arboretum in China, Japan, or elsewhere. He paid several visits to Great Britain and always spent much of his time at Kew. In addition he paid visits to see all the more interesting specimens of trees and shrubs which flourish in Great Britain but may not be hardy in the more severe climate of eastern North America. His death is a great loss to botanical science both in America and in Great Britain, where he had many friends.

It is with great regret that we receive the news of the death of the distinguished French man of science, Daniel Berthelot. The son of Marcelin Berthelot, the centenary of whose birth is being celebrated in the present year, Daniel Berthelot showed much of the originality and width of outlook of his illustrious father. After periods of service at the Sorbonne and the Collège de France, he became professor of physics at the École de Pharmacie, and it was in his laboratory at Meudon that he made most of those discoveries and researches in the fields of pyrometry, temperature scales, gas densities, and the chemical effects of ultra-violet light for which his name will be held in remembrance. The famous characteristic equation which he introduced has become second in importance only to that of Van der Waals, and is more accurate than the latter within its legitimate field of application. Daniel Berthelot laid the foundations of accurate gas thermometry and the physical methods of determining molecular and atomic weights which have closely rivalled, if not even excelled, the most accurate procedure of gravimetric analysis. In the field of chemistry his most notable discovery was probably the production of formaldehyde when a mixture of water vapour and carbon dioxide is exposed to ultra-violet light, and of formamide when carbonic oxide and ammonia are similarly irradiated. These syntheses lie at the foundations of biochemistry.

The issue of the *Physikalische Zeitschrift* for Feb. 1 contains a notice of the life and work of Prof. Des Coudres of Leipzig, who died on Oct. 8, written by his colleague, Prof. W. Wien. Des Coudres was born on Mar. 13, 1862, at Veckerhagen, near Göttingen, of a family which had left the Spanish Netherlands during the religious wars. He was at school at Cassel until 1881 and then studied in succession at Geneva, Leipzig, and Berlin. He took his doctor's degree under Helmholtz at Berlin in 1887 and in 1889 went back to Leipzig as assistant to Wiedemann. In 1897 he was appointed professor of applied electricity there, but in 1901 went to Würzburg as professor of theoretical physics and in 1903 succeeded Boltzmann at Leipzig. He never married, and was content to live for twenty-three years in his rooms in the attic of the Physical Institute. He was fond of travelling, particularly in warm sunny countries. He is probably best known for his work on the speed of cathode rays.

We regret to announce the death of Dr. S. W. Richardson, formerly principal and professor of physics at University College, Southampton, on April 10, aged fifty-seven years.

News and Views.

In a paper entitled "Observations upon Mining Law in the Empire," read before the Institution of Mining and Metallurgy on April 21, Mr. Gilbert Stone introduced a subject of vital importance to the mineral industry. Laws and regulations frequently contain provisions that tend to hinder the industry they seek to assist; this may be due to the operation of changed local conditions; it is obvious that regulations suited to a new and undeveloped territory become unsuitable when the region has been occupied by a rapidly growing agricultural community or by large industrial centres. On the other hand, the law may be radically wrong: China, with its great resources, has little mineral development because the law and customary rules—which permit the pursuit of minerals across anybody's land, without compensation or regulation, but only by a special caste, whose members must be bought out—operate to prevent modern methods of development; capital cannot be attracted in such circumstances. That is an extreme case, but cases could be cited from parts of the British Empire of laws that have prevented or seriously hampered either prospecting or development.

While admitting that local differences must be respected in the framing of mineral law, it is clear there is too much diversity in the regulations for prospecting, in the charges for rents and royalties, and in the method of their determination; also in the mode of staking a claim and obtaining a title, and there are still regions where it is uncertain in whom the mineral rights reside. In the British territory in Africa alone, there are twenty-one different codes of mining law. Mr. Stone considers that our mining codes should make matters easier for the pioneer prospector, for a single discovery may alter the whole history of a country in which it is made. In order to encourage the free flow of capital, everything should be done to establish clear and unimpeachable titles, for suitable terms. The short-term lease may be very wasteful of the country's resources. The Advisory Council on Minerals of the Imperial Institute, to which Mr. Stone is legal consultant, is performing a valuable function in assembling for comparative study and analysis the diverse forms of mining law now current.

To enable the manufacturer and the tax-payer to appreciate what the State-aided research associations in Great Britain have achieved in the first few years of their existence, the Department of Scientific and Industrial Research has just published a report on "Co-operative Industrial Research" (London: H.M.S.O. 9*d.* net), which gives an account of their activities, grouped under results of commercial value and indirect benefits to industry. Another section of the report deals with the measure of support which each association has been given by the industry it serves. Presumably the report is intended to arouse public opinion to the necessity for industrial research, but it is an uninspiring publication. The information given is scanty in the extreme, the research needs of the industry are never clearly stated, and very few of the problems which are absorbing the attention of the scientific staffs are mentioned. Many of the so-called results recorded cannot be classed as research: they merely serve to display the barrenness of ideas and crudities of practice which characterise many British manufacturing firms. The report states that "many of them [the research associations] have directed their attention to removing defects and avoiding waste: it may be said that there is a general tendency to seek rather to improve the efficiency of existing industrial processes than to devise radically new processes or products." The impression the report is likely to produce on the tax-payer, and even on the manufacturer who knows what real research means, is that the direct and indirect benefits accruing to industry as the result of the activities of the associations have been bought very dearly. The photographs of buildings and laboratories published in the handbook will probably tend to reinforce that impression rather than to remove it.

This week is marked by the centenary of the birth of Capt. John H. Speke, African explorer and discoverer of the source of the Nile. Speke was born near Ilchester in Somersetshire on May 4, 1827. Educated for the Indian Army, whilst on service his inclinations were strongly set towards the exploration of central equatorial Africa. After soldiering work in the Crimea, the opportunity came in 1856 of associating himself with Richard Burton in an official expedition to central Africa, the chief objective being the traditional equatorial lakes. On July 9, 1858, Speke himself left the base Kazé, marching north, and on July 30, 1858, after an arduous journey, reached the great expanse of water named by him Victoria Nyanza. His unalterable belief that he had discovered the source of the Nile was contested by Burton. On May 8, 1859, Speke arrived in England. His ardour undiminished, he immediately engaged in preparations for a supplementary expedition, avowedly for the purpose of establishing the truth of his assertion that Lake Victoria Nyanza would eventually prove to be the source of the Nile. In this project for confirmation he had the full support of Sir R. Murchison and the Royal Geographical Society. Speke left Zanzibar in September 1860, accompanied by a fellow explorer, James A. Grant (also born in 1827). The object was ultimately achieved. The point where the Nile leaves the Victoria Nyanza was named Ripon Falls. The fact that the Nile had been traced to its source created a profound sensation when communicated at a meeting of the Royal Geographical Society on May 11, 1863, and Speke's book, "Journal of the Discovery of the Source of the Nile," published in 1863, was widely read. Murchison stated that in discovering the source reservoir of the Nile, Speke had succeeded in solving the "problem of all ages."

Sir Christopher Wren and his scientific contemporaries, Elias Ashmole and Dr. Robert Plot, are to be commemorated on Tuesday, May 17, at Oxford, by the unveiling of three armorial windows in the Old Ashmolean Museum by the Chancellor of the University, Viscount Cave. The window to Wren has been appropriately presented by the fellows of the Royal Institute of British Architects, who held a most successful meeting in Wren's Sheldonian Theatre in the summer of 1925, and it is expected that the president of the Institute will attend in person to pronounce an eloge on his great predecessor. The windows to Ashmole and Plot are presented by the colleges with which they were respectively connected while in residence in Oxford. By the addition of these windows to the window to John Tradescant, described in these columns on Dec. 4 last, not only is a very beautiful decoration being added to the fine staircase of the Old Ashmolean Museum, but also appropriate though tardy recognition is being made to that singular group of seventeenth-century pioneers who by their joint endeavours provided England with her first public museum of natural history. A coloured drawing of the new windows is being issued with the May number of the *Architectural Review*.

With reference to the recent notice of the centenary of death of Ernst Chladni, and of his work (Nature, April 2, p. 503), a correspondent writes that the vibrations of metal or glass, which under certain conditions produce the so-called "Chladni's figures," would seem to have engaged the attention of the versatile Robert Hooke when in charge of experiments conducted at Gresham College in the early days of the Royal Society. It is recorded that on Mar. 30, 1671, at the Royal Society, Mr. Hooke produced his glass-bell with flour in it, to show to the eye that, according to the several strokes or pulses made upon the glass, the air thence receives as many impressions; it being manifest by this experiment that as every different stroke made a different sound, so the making a different impression upon the flour gave it as many different motions. It appeared also that the powder goes from the place whence the pulse comes; and that in a perpendicular pulse the powder has a kind of vibration; and also, that so long as the sound of the bell lasts the powder seems to be fluid, but as soon as it ceases the powder also becomes still. It was thought that this experiment might contribute to the understanding of the nature of the internal motion in bodies, and Mr. Hooke was "to prosecute it." On April 27 following, the matter was again referred to at the weekly meeting of the Royal Society, and it was moved that the experiment with the glass-bell and powder should go forward. Hooke does not, however, appear to have met these wishes.

The art of television is making progress. Mr. J. L. Baird is endeavouring to transmit images of living faces across the Atlantic, and on April 7 the American Telephone and Telegraph Company gave a successful demonstration of television. The president of the company, Mr. Gifford, who was at New York, had a telephone conversation with Secretary Hoover at Washington. The television apparatus also permitted him to see as well as hear Mr. Hoover. By a special device, also, guests assembled at New York could see the expression of his face as he talked and hear him simultaneously on a loud-speaking telephone. The guests at New York afterwards saw individually by television and talked with the guests at Washington. They also saw the face of a clock shown by a member of the staff at the Bell Telephone Laboratories, Whippany, New Jersey. The experiments prove that under favourable atmospheric conditions it is possible to send images over any distance by television. It is impossible, however, to predict as yet when a cheap and trustworthy system of radio-television will be perfected. An entire scene has to be sent in small individual parts in less than the fifteenth of a second. Only apparatus of extreme sensitivity to light can be used, and the exactness of the synchronisation must not exceed about the hundred-thousandth part of a second. Every one must admire the courage of the inventors who have partially overcome these difficulties.

In the appeal for membership issued by the National Union of Scientific Workers, which was discussed in a leading article in our issue of Mar. 5, it is categorically stated that the strike is not a possible weapon for such a society, and the possibility of its employment has never been considered by its executive. This statement has led Mr. J. Bertram Ward, in a letter to the Editor, to comment on the possible ways in which the force of numbers is to be applied to effect the principal end the society has in view, the improvement of the economic position of professionally qualified scientific practitioners. Will this force be exerted to control the freedom of action of its members? "Is professional dignity to descend to collective bargaining?" Mr. Ward asks, and "is such bargaining ever more effective than education" by means of "reasoned yet vigorously insistent propaganda?" Propaganda in this direction, he continues, "is a method which is irresistible and leaves the individual unrestricted." But the fact cannot be ignored that the salaries being offered to scientific workers, even by the State department responsible for scientific and industrial research, are now reduced to a level which must inevitably react adversely on the quality of new entrants to the profession of science. The department would probably welcome any action which would enable it to represent to the Treasury the need for making science an attractive career for the best brains of Great Britain. Scientific workers themselves are in the best position to state what constitutes an attractive career, and they could, if they brought the collective force of a united profession to bear upon individual members, make it practically impossible for employing bodies to impose upon qualified and experienced scientific workers salaries and conditions of employment which would not be tolerated by members of any other profession.

In connexion with the Smoke Abatement Act which comes into force on July 1, the paper by J. B. C. Kershaw on the relationship between atmospheric impurity and electricity supply, which is published in *World Power* for April, is of interest. The comparisons made between various towns are naturally only rough approximations, as there are many other factors, for example, the consumption of gas per head, which affect the degree of atmospheric pollution. The results, however, give indications that, as the use of electricity increases, the soot and dust fall per annum diminish in inverse ratio. The official figures show also that the consumption of electricity per head of the population depends very largely on the price charged to the private consumer. There are some notable exceptions to these statements, the explanation of which demands further study. The facts brought out by Mr. Kershaw prove that the data now being collected by the Advisory Committee on Air Pollution will prove of value. Birmingham and London can boast of a degree of atmospheric cleanliness which is satisfactory. The atmospheric pollution in these cities is only double that of a purely residential town like Southport and only one-third that of St. Helens or Burnley.

How rapidly the literature of earthquakes is growing is shown by the issue begun last year of the *Bibliographical Bulletin*, prepared by the Eastern Section of the Seismological Society of America. The *Bulletin* appears quarterly, and the recent issue (for Oct.-Dec. 1926) contains one hundred entries, besides addenda, many of which are accompanied by brief summaries. Copies of papers for notice in future numbers of this useful journal should be sent to the Dominion Observatory, Ottawa, Canada.

The Air Ministry has published the fourth edition of the "Marine Observers' Handbook" (London: H.M.S.O. 3*s*. 6*d*.). The pamphlet has been thoroughly revised and contains, in addition to chapters on the use of instruments, sections on non-instrumental observations, including optical phenomena and hydrographic observations. There are also some useful correction and conversion tables, and a tinted supplement illustrating the chief forms of clouds. Though the publication is mainly intended for marine observers, it would prove of almost equal value at land stations.

The Report of the Bankfield Museum, Halifax, for the year 1925–26, is apparently the first to be published by the committee, which thus signalises the first year of service of Mr. G. R. Carline, who succeeded the late H. Ling Roth on April 1, 1925. Mr. Carline seems to be carrying on the good work with much energy. There were three special exhibitions of art objects during the year. The collection of pottery has been rearranged; the case devoted to native pottery of British Guiana is of particular importance. Room has been made for an extension of exhibits relating to weaving, which is the subject of chief interest to Halifax. Many additions have been made to this series, as well as to the collection of bygones and objects illustrating local history. The provision of an index to the report is a feature to be commended.

The *Proceedings of the Indian Association for the Cultivation of Science* are now issued under the title, *Indian Journal of Physics*. Part 2 of Volume 1 contains the report of the Association for the year 1925 presented by the secretary, Prof. C. V. Raman. The cost for the year was about 40,000 rupees, towards which the Indian Government contributed 10,000 rupees. Considerable additions have been made to the library, the laboratory apparatus, and the workshop, and during the year fifteen research workers from various parts of India carried out investigations in the laboratory on the scattering of light, the acoustics of the violin, the magnetic susceptibilities of gases, and the properties of surface films. More than twenty papers have been published during the year, four in the *Proceedings of the Royal Society of London*, three in the *Philosophical Magazine*, and the remainder in other scientific journals.

Number 75 of the *Miscellaneous Publications* of the Bureau of Standards, Washington, consists of the annual report of the Director, Dr. G. K. Burgess, for the fiscal year ending June 1926. The total expenses were nearly 2 million dollars, of which 516,000 dollars represent salaries, 232,000 dollars tests of structural materials, 174,000 dollars industrial research, 111,000 dollars standardisation of the products of industry, 100,000 dollars investigations of public utility services and conditions, 70,000 dollars equipment, and 54,000 dollars investigations for the Navy and for aviation. Close contact with the industries of the country is maintained by means of advisory committees composed of technical representatives from the industries and by the research associates appointed by the industries to carry out researches at the Bureau. A visiting committee reports once a year to the Secretary of Commerce on the efficiency of the Bureau. Some of the reductions effected on economical grounds in the varieties of articles of the same description produced by manufacturers are remarkable, *e.g.* files and rasps, from 1351 to 496; sheet steel, from 1819 to 263; concrete blocks, tiles, and bricks, from 115 to 24.

An Illustrated Guide to the Singapore Botanic Gardens has just been published. These Gardens are among the finest of tropical botanic gardens, and as the last guide (issued 1889) has been out of print for some years, the new issue has been long overdue and supplies a much-needed desideratum for botanists and general visitors. In recent years alterations of considerable magnitude have been carried out; and while due attention has been paid to scientific considerations in laying out the gardens, the scenic and landscape aspects have not been neglected. Here most species of the Indo-Malayan flora as well as other forms have been brought together and skilfully arranged. Some species are grouped on conventional garden lines, and others are assembled in a kind of natural jungle. In the Guide the vegetation is described section by section of the Garden, with interesting notes on large numbers of the species. The work is profusely illustrated with photographs of the more striking scenes and species, while an index of species and a good map of the Gardens complete the book.

The "Report on the Health of the Army for the Year 1925" (vol. 61) (London: H.M.S.O. 3*s*. 6*d*. net) has recently been issued, fourteen months after its predecessor, and it is hoped that the report for 1926 will be published still more quickly. The report is arranged by Lieut.-General Sir Matthew Fell, Director-General of Army Medical Services, on the same lines as those for the two preceding years. Throughout the year the health of the troops at home and abroad was satisfactory, and the incidence of sickness shows an improvement on that of the preceding year. Malaria accounts for the largest number of admissions to hospital, and tonsillitis comes third on the list. Only 218 cases of enteric fever occurred in the whole army, of which 184 cases were in India. Inflammation of the middle ear (449 cases) again takes first place as a cause of invaliding out of the army.

The danger to man of the bites of certain spiders seems, after many years of uncertainty, now to be established beyond doubt. Following the description of arachnidism as a definite clinical entity by Dr. Bogen of Los Angeles (Nature, Dec. 25, 1926, p. 927), the death of a child from a spider's bite has been reported from Sydney (*Sydney Morning Herald*, Feb. 24, 1927) The spider responsible, produced at the inquest, was identified as *Euctimena tibialis* Rainbow, a rare trap-door or mygalomorph spider. The scientific interest of this lies in the fact that hitherto all the authenticated and most of the suspected cases of poisoning by spiders have been attributed to the genus Latrodectus, of the family Theridiidæ, whereas Euctimena is a member not only of a different family but also of another sub-order of spiders.

Most countries are now undertaking organised research on the causation, prevention, and cure of cancer, and the University of Sydney has issued a pamphlet on its cancer research and treatment organisation (The Australian Medical Publishing Co., Sydney). A fund of £130,000 has been collected from various sources. Three main lines of research have been developed during the last three years: *bio-physical*, for which a special laboratory has been equipped; *bio-chemical*, and *biological and pathological*, which are being pursued in the University and Hospital departments. It is also proposed to establish a radium institute for treatment.

We have received the annual report for the year ended July 31, 1926, of the National Institute for Research in Dairying, which now forms a constituent part of the University of Reading. The Report summarises the work of the various departments, the condition of the farm and farm buildings, the publications issued, and the financial needs of the Institute. As regards the last named, £30,000 is required for adapting the Shinfield Manor estate which has been acquired for the work of the Institute, towards which £20,408 has so far been collected by grants, donations, and subscriptions

The International Commission on Illumination will hold a short session at Bellagio on Aug. 31–Sept. 3. A plenary session of the Commission should take place in New York this year, but for various reasons it has had to be postponed until 1928. The session at Bellagio is solely one for the executive committee and the various sub-committees appointed by the Commission to study such problems as factory and school lighting, automobile headlights, heterochromatic photometry, definitions and nomenclature, and colorimetry. It is hoped that the meetings of the sub-committees will do much to facilitate their work and lead to a successful meeting next year, besides enabling the countries which have recently joined the Commission to become acquainted with its work The meeting at Bellagio will be under the presidency of Dr. E P. Hyde, and the arrangements are being carried out by the Italian National Committee on Illumination.

At the anniversary meeting of the Linnean Society to be held on May 24 next, the following medals will be awarded: The Linnean Medal in gold, given each year to an eminent biologist as an expression of the Society's estimate of his services to science, usually to a botanist and a zoologist in alternation, will be presented to Dr. Otto Stapf. Dr. Stapf has served as Keeper of the Herbarium at Kew, and is now the editor of the *Botanical Magazine*. The Crisp Award was established by a donation of £200 by the late Sir Frank Crisp, for the best paper dealing with microscopical research by a fellow of the Society since the last award, and is made at intervals of five years, accompanied by a medal in bronze and the balance of the income of the principal. The recipient this year will be Prof. Herbert Graham Cannon, professor of zoology in the University of Sheffield, for a paper on the "Post-Embryonic Development of the Fairy Shrimp (*Chirocephalus diaphanus*)," issued last year in the zoological journal of the Society.

The nineteenth meeting of the Australasian Association for the Advancement of Science will be held in Hobart, Tasmania, during the week commencing Jan. 16, 1928. The president-elect is Mr. R. H. Cambage. The following presidents of sections have been elected: Section B (Chemistry), Prof. H. G. Denham, Canterbury College, Christchurch, N.Z.; Section C (Geology and Geography), Prof. L. A. Cotton, University of Sydney; Section D (Zoology), Dr. Colin Mackenzie, Director of the National Museum of Australian Zoology, Melbourne; Section E (History), Mr. T. Dunbabin; Section F (Anthropology), Dr. R. H. Pulleine; Section G (Social and Economic Science and Statistics), Prof. R. C. Mills, University of Sydney; Section H (Engineering and Architecture), Mr. Alan C. Walker; Section I (Medical Science and National Health), Dr. J. H. L. Cumpston; Section J (Education, Psychology, and Philosophy), Mr. M. P. Hansen; Section K (Agriculture and Forestry), Prof. A. J. Perkins, Director of Agriculture, South Australia; Section L (Veterinary Science), Mr. Max Henry; Section M (Botany), Prof. T. G. B. Osborn, University of Adelaide; Section N (Physiology and Experimental Biology), Prof. H. G. Chapman, University of Sydney; Section O (Pharmaceutical Science), Mr. Edward Mayhew. The honorary general secretary of the Australasian Association is Dr. A. B. Walkom, Royal Society's House, 5 Elizabeth Street, Sydney, and the honorary secretary for the Hobart meeting, Mr. Clive Lord, Director of the Tasmanian Museum, Hobart.

A useful and interesting catalogue (No. 284) of second-hand books, and publications of learned societies has just been issued by W. Heffer and Sons, Ltd., 4 Petty Cury, Cambridge. The list comprises upwards of 2000 volumes and is classified as follows: Agriculture, husbandry, and farriery; botany; chemistry, chemical technology, and metallurgy; geology, mineralogy, and palæontology; zoology and biology; anthropology and ethnology; and mathematics, physics, astronomy, and engineering. Included are a number of works from the library of the late Prof. A. Dendy.

In the list of forthcoming books of the Oxford University Press which has just reached us we notice the following:—"Stars and Atoms," Prof. A. S. Eddington. "Conditioned Reflexes of the Cerebral Hemispheres," Prof. I. Pavlov; translated under the supervision of Dr. G. Anrep. "Chemistry," W. H. Barrett. "Animal Biology," Prof. J. S. Huxley and J. B. S. Haldane. "How a Tree Grows," Prof. W. Somerville. "The Flora of Oxfordshire," Dr. George Claridge Druce; second edition. "Oxford Forestry Memoirs." No. 7: "The Gold Coast Forest—A Study in Synecology," Major T. F. Chipp. "Grass Land: Its Management and Improvement," R. G. Stapledon and J. A. Hanley. "The Conquest of the Air," C. L. M. Brown. "A Bird Book for the Pocket," E. Sandars. "Advanced Constructive Geometry," J. F. Dowsett. "Mathematics for Students of Technology": Senior Course, L. B. Benny. "Elements of Mining Science," D. E. Thomas. "A B C of Plastering," A. H. Telling. "Elementary Building Science," A. Everett. "Industrial Electric Motors," W. Wilson. "Essays in Ægean Archæology." Papers presented to Sir Arthur Evans. "The Corridors of Time," H. Peake and Prof. H. J. Fleure. 1. "Apes and Men"; 2. "Hunters and Artists"; 3. "Peasants and Potters"; 4. "Priests and Kings." "Environment and Race": a study of the evolution, migration, settlement, and status of the races of man, Dr. T. Griffith Taylor. "Kingship," A. M. Hocart.

Applications are invited for the following appointments, on or before the dates mentioned:—An assistant lecturer in economics in the University of Sheffield—The Registrar (May 12). A university lecturer in mathematics in the University of Cambridge—Prof. A. S. Eddington, the Observatory, Cambridge (May 14). A principal of the Municipal School of Science, Technology, Commerce, etc., Bournemouth—The Director of Education, Town Hall, Bournemouth (May 14). A junior scientific officer on the Air Ministry Scientific Research Staff, for research in connexion with electrical appliances, with special reference to electrical ignition apparatus—The Chief Superintendent, Royal Aircraft Establishment, South Farnborough, Hants (May 18, quoting A.157). Junior technical officers for the Wireless Experimental department of the Royal Aircraft Establishment—The Chief Superintendent, Royal Aircraft Establishment, South Farnborough, Hants (May 21, quoting A.160). A lecturer in veterinary pathology bacteriology and protozoology in the University of Sydney—The Agent-General for New South Wales, Australia House, Strand, W.C.2 (June 18). A professor of organic chemistry at the Indian Institute of Science, Bangalore—Dr. M. O. Forster, c/o Messrs. Jeremiah Lyon and Co., 4 Corbet Court, E.C. 3 (June 29). A laboratory assistant, with experience of section cutting and general pathological and bacteriological work, at the Lincoln County Hospital—The Secretary-Superintendent, County Hospital, Lincoln. A graduate in engineering to take mechanical engineering subjects at the Dartford Technical College—The Principal, Technical College, Dartford. Research chemists in the research laboratories of Boots Pure Drug Co., Ltd.—Boots Pure Drug Co., Ltd., Chief Research Chemists, Station Street, Nottingham.

Our Astronomical Column.

Comets.—Four comets are likely to be fairly easy telescopic objects during May. Ephemerides of these, for 0h U.T., are given below:

			R. A.			N. Decl.		log r.	log Δ
Comet 1926 f, Comas Sola.	Apr.	30.	6h	48m	26s	33°	2′	0·2626	0·3468
	May	8.	7	12	32	32	37	0·2676	0·3602
		16.	7	36	20	31	57	0·2730	0·3741
		24.	7	59	32	31	4	0·2700	0·3874
1927 c, Pons-Winnecke.	Apr.	30.	14	57	16	48	13	0·0999	9·6286
	May	8.	15	1	18	50	33	..	9·5704
		16	15	6	30	52	30	0·0615	9·5041
		24.	15	14	30	53	55	...	9·4206
1927 d, Stearns	Apr.	29.	14	42	20	10	37	0·5683	0·4417
	May	7.	14	34	31	13	18	0·5692	0·4473
		15.	14	26	56	15	42	0·5703	0·4564
		23.	14	19	52	17	47	0·5715	0·4683
1927 e, Grigg-Skjellerup	Apr	30.	6	46	25	9	16	9·9571	9·6025
	May	4.	6	57	4	12	13	9·9531	9·5650
		8.	7	8	58	15	45	9·9510	9·5248
		12.	7	22	29	20	3	9·9509	9·4822
		16.	7	38	28	25	16	9·9527	9·4386
		20.	7	58	5	31	33	9·9551	0·3957

Popular Astronomy for April contains a photograph of 1927 d taken by Prof. G. Van Biesbroeck on Mar. 13. There was a large conspicuous coma, and a faint tail 10′ long in P.A. 215°. The nucleus was of about mag. 11, and was photographed with 20 sec. exposure.

This comet has the fourth greatest perihelion distance known, 3·68 units; those exceeding it are 1925 a, 4·18 units; 1729, 4·06 units; 1914 III., 3·75 units.

The *Melbourne Age* for Feb 18 contains the interesting announcement that Mr. Z. A. Merfield proposes to use the great Melbourne reflector for spectroscopic observations of the comet Pons-Winnecke. He is the son of Mr. C. J. Merfield, assistant at Melbourne Observatory, and obtained very successful photographs in Sumatra of the solar eclipse of January 1926. His spectrograph is being mounted on the reflector, which has been out of use for forty years. The comet goes south very rapidly after its perihelion passage on June 21, so it will then be very favourably placed for southern observers.

Prof. G. Van Biesbroeck followed comets 1926 e (Giacobini-Zinner), 1925 a (Shajn-Comas Sola), 1926 g (Neujmin) up to the first week in March: they had been under observation for five months, two years, and four months respectively. He noted that 1926 g had been of mag. 12 early in February, but after that it faded rapidly. 1925 a had sunk to mag. 16 and it was impossible to follow it for longer.

Research Items.

Pre-Sumerian Man in Arabia.—On their return from Kish through the desert lying between Mesopotamia and Palestine in the winter of 1925–26, Mr. L. H. Dudley Buxton and Mr. Henry Field devoted to a search for evidence of the existence of early man in this area such time as was available during the halts of the armoured-car patrol which they accompanied by permission of the Air Marshal. In *Discovery* for April, the former describes the journey and the circumstances in which quite a considerable number of flint implements were found at each stage of the journey. It is interesting to note that the Arab desert police denied the use of flint for any purpose other than strike-a-lights, thus authenticating certain flakes of a somewhat modern appearance. Evidence the most definite in character was obtained at Landing Ground R, a number of implements of Aurignacian type being found. Near Air Force Landing Ground H was found a large lake of perhaps a hundred acres in extent but of not more than a foot deep. On the lower of two surfaces exposed in ancient times, a large number of small tools were found, the other surface showing no evidence of man's handiwork. The implements found on the journey as a whole belong to the middle and late palæolithic age, with one laurel-leaf arrow-head belonging probably to the new stone age. Although the desert conditions are not now such as to support human life, the fact that the implements are found in hollows and little dry valleys suggests that under different climatic conditions, such as probably prevailed in palæolithic times, water flowed down the valley bottoms. This upland divide thus furnishes evidence of man's existence at a period long anterior to that of the material from Mesopotamia itself, where nothing primitive but only the remains of a fairly advanced culture have as yet been found.

Shilluk Begging Customs.—Among some notes on the customs of the Shilluk, contributed to *Sudan Notes and Records*, vol. 9, No. 1, by the Rev. D. S. Oyler, is an account of begging customs observed especially by women, who seem to derive much pleasure in begging cattle from the richer men of the tribe. The occasion is observed as a holiday for the women of the village, all of whom take part unless there should be too many, when only the women of a certain age go. Women from two villages never unite on these expeditions. The proper time for the begging dances is just before the rains, though they may be held at any time during the dry season. The man from whom the women are to beg is selected before the expedition starts. It is regarded as an honour. As a rule the man selected is not one of their own village, but should he be, the women ask for a sheep only. Although the women usually object to leaving their babies, on these occasions they leave them at home in charge of the men. Before starting a leader is chosen, known as a *bana*, who has the power of a magistrate, is crowned as a village chief is crowned, and deals with any trouble among the women. She acts as chief in any expedition made later by the same party; and in the village she has the right to judge in any dispute strictly between women. In the event of a refusal of an ox, a man's wife may intercede for the visitors, dancing among them; but if the owner persists in his refusal, the party departs cursing him and his family. Any sickness which follows is attributed to this curse, which can only be removed by the return of the party, the gift of an ox, and a petition by the women for the removal of the curse, accompanied by the sprinkling of ashes. A similar custom prevails at the time of threshing corn, when the women sit in silence around the threshing floor holding out their gourds, into which corn is placed when the threshing is finished.

The Species and Sex-Ratios of Raia.—Augusta Lamont has recorded (*Proc. R. Phys. Soc. Edin.*, 21, pp. 73-82, 1926) the relative frequency of the species of the genus Raia (the skate) and the sex-ratios of 1714 specimens delivered to the Department of Zoology, University of Edinburgh, for class purposes during the years 1920–1925. These fish were probably for the most part caught in the Firth of Forth or in the neighbouring part of the North Sea. Five species were represented—*Raia radiata* 1069, *R. circularis* 381, *R. batis* 227, *R. clavata* 19, and *R. fullonica* 18. The author points out that to some extent artificial selection, *e.g.* of specimens of convenient size for laboratory work, may have operated to bring about a modification in the relative numbers, so that the proportions are not necessarily indicative of the natural frequency, though they are not markedly at variance with the observations of Day. *R. radiata* was the commonest species from October to May, reaching a maximum in February and March; *R. circularis* was the most frequent species in July but was scarce in the winter and spring. The observations on the sexes cover only four years, and for the five species taken together there were 757 males and 727 females. During the first three years *R. radiata* was represented by 347 males and 310 females, but in the fourth year the respective numbers were 102 and 154, a striking reversal of the previously existing ratio.

The Eggs and Young of Halobates.—Dr. H. C. Delsman has had exceptional opportunities for studying this interesting marine insect, the habits and young of which he describes in a recent paper ("On the Propagation of Halobates," *Treubia*, vol. 8, Livr. 3-4, 1926). During his cruises with the investigation-steamer *Brak* over the Java Sea and along the east coast of Sumatra, the eggs and adults were frequently found. The author is emphatic in stating, contrary to the opinion of other observers, that Halobates cannot dive, and that, if forced under water, it dies after making futile swimming movements in attempting to regain the surface. He distinguished five different sorts of eggs, all attached by a glue-like substance to various floating objects such as seaweeds, Spirula and Sepia shells, and birds' feathers; also coal slag, wood, or cork. Sometimes thousands of eggs were found on one object, and this must have been the result of the egg-laying of many individuals, as no more than twenty-five eggs have been found inside one female. Clear figures are given of the embryo in its various stages. Directly the larva hatches it moults, leaving its skin behind attached to the egg membrane, and the young Halobates move to the surface, adopting at once the mode of life of the adult, its form scarcely differing at all from that of the adult. These are valuable notes on the life-history of members of a little-known group.

A Tachinid Parasite of the Larvæ of Coconut Moths.—The larvæ of certain moths of the family Zygænidæ are serious enemies of the coconut, and in the *Malayan Agricultural Journal* for Oct. 1926, Mr. B. A. R. Gater contributes some observations on the life-history of the Malaysian coconut moth

(*Artona catoxantha*). It appears that the larvæ of this insect are parasitised by a tachinid fly, *Ptychomyia remota*. The latter beneficial insect, however, suffers from parasites of its own, which militate to a considerable extent against its utility as a natural controlling agent. In a second paper Mr. Gater gives further details concerning the biology of this tachinid. Its liability to the attacks of hyperparasites is further dilated upon: but in spite of their activities the insect is capable of destroying 30 per cent. to 40 per cent. of its host, and in most cases exceeds that figure. Inquiries were received from Fiji with respect to the possibility of importing into those islands parasites of the Artona moth with the object of testing their effects on an allied zygænid *Levuana iridescens*. The latter insect is an important pest of coconut in Fiji, and the need for attempting its control was urgent. After considerable difficulty, some 300 adult examples of the Ptychomyia reached Suva alive, and it was found that they parasitised the Levuana larvæ as readily as those of their Malayan host. The tachinid has proved its value, and is reported as destroying at times up to 90 per cent. of the Levuana larvæ. It is now well established in Fiji, where its greater efficiency is probably due to its freedom from the hyperparasites that are so prevalent in the Malay States.

Genetics of Dormant Maize.—Genetical investigations at the Connecticut Agricultural Experiment Station (Report 49) have shown that the mature and completely developed dormant maize seed is the outcome of a number of processes in which the cumulative action of at least 27 Mendelian factors is essential, and suggest that further work will probably reveal the necessity for several more. Defective seeds may be hereditary or non-hereditary. In the former case the condition frequently arises by mutation in homozygous inbred strains; it is estimated on an average that one plant in every thirty is heterozygous for defective seeds. Fertilisation occurs in these cases, but the development of embryo and endosperm fails or is rudimentary only. Non-hereditary defectives fall into four classes according to the cause of their abnormal condition. *Parthenocarpic* defectives arise from failure of the pollen tube to reach the micropyle, and consequently neither embryo nor endosperm is formed. The age of the silks and pollen, and probably also environmental conditions, influence the production of this type of seed. *Arrested* seeds, however, contain both embryo and endosperm, but owing to competition of physiological dominance of the adjacent normal seeds, their development is retarded. *Germless* seeds result from a single instead of a double fertilisation and lack an embryo, while *miniature* defectives, though normal in form, are reduced in size, due possibly to an abnormal number of chromosomes in the endosperm. Altogether thirteen factors have been found which may cause the formation of defective seeds, and five additional factors which in affecting the endosperm may also prevent normal seed development. On the other hand, nine factors have been found which induce premature germination by inhibiting dormancy and are therefore as fatal to the seed as the retarding factors. Since the hereditary units involved in the short period of the plant's life between fertilisation and the resting stage of the embryo are apparently so complex, knowledge of those concerned with the ontogeny of the entire plant is clearly of a rudimentary nature only.

Palæontology in South Africa.—Last year, for the first time in the history of the Geological Society of South Africa, the presidential chair was occupied by a palæontologist. The anniversary address by Dr. S. H. Haughton was therefore of exceptional interest, since it passed in review the leading facts of present knowledge with regard to animal remains in South Africa, their relation to similar faunas from other regions, and the many problems that still await further discoveries for their solution. Of 186 marine species from the Bokkeveld Beds, 40 are common to South America and 71 are varieties of, or are closely allied to, South American forms. The fauna contains an almost negligible European element, suggesting that it flourished along the shores of the Devonian land area that has been called Falklandia. The South African Permian fauna is found in Russia and Scotland, but is absent from central Europe. The conclusion is reached that there was no passage across the Tethys by the Iberian land-bridge, but that migration occurred by way of Syria to Persia or the Caucasus and thence northwestwards. It is pointed out that much more work is necessary to determine the geographical changes that have taken place since the Cretaceous, and an appeal is made to the universities and museums to stimulate and encourage further interest in the study of palæontology, which hitherto in South Africa has been regarded as little more than a subsidiary adjunct to geology.

Oil Contamination as a Climatic Factor.—Mr. L. A. Ramdas, of the Meteorological Office, Karachi, in a letter to the Editor, makes the novel suggestion that the oil which is now being discharged into the sea in appreciable quantities, especially by the wreck of oil-bearing ships, may have a measurable effect on the total rainfall of the globe. It is well known that oil on a water surface spreads out into a very thin film, and it is natural to expect this film to interfere with the free evaporation of the water, a result which has been confirmed by experiment. A decrease of evaporation from the oceans would result in a general decrease of rainfall over the globe. Mr. Ramdas tested this by comparing the mean annual rainfall at 142 stations for the two periods 1880–1900 and 1900–1920, and he found that the mean of the second period was less than that of the first by about one per cent. over the earth as a whole and four per cent. over the tropics. He recognises that this result is not conclusive, but hopes to obtain further evidence, especially by examining the rainfall of individual years in relation to the number of wrecks of oil-bearing ships.

An Ancient Theodolite.—The theodolite in its simplest form is due to Leonard Digges of University College, Oxford (about 1550), and was first described in 1571 under the name of the 'Topographical Instrument.' An example of this instrument made by Humphrey Cole in 1586, with the improvements of the theodolite of Bleau of a later date, was discovered in St. John's College library and is now in the Lewis Evans collection of scientific instruments. A reprint of Digges' description in his "Pantometria" of 1571 has been published with a short preface by Dr. R. T. Gunther (Old Ashmolean Reprints No. IV. Oxford: 3s.). It consists of seven chapters of Longimetra, which with Planimetra and Stereometra formed the three books of "Pantometria." Copies of the original diagrams and plates are given in the reprint.

Mica.—With the growth of electrical and allied industries, the supply of mica has become a matter of great importance. Its perfect cleavage, transparency, and lack of colour when in thin sheets; its flexibility, toughness, and non-conductivity of heat and electricity; its resistance to high temperatures, sudden changes of temperature, and to chemical decomposition, constitute an assemblage of properties possessed by no other single mineral and by no artificial products. The mica of commerce is restricted almost entirely to the varieties *muscovite*, potash mica, and *phlogopite*, magnesian mica. Slight differences in the physical properties of these micas give rise to forms particularly suited for special purposes. Thus the Indian ruby mica is the best for condensers; the hard green Carolina mica is the most satisfactory for use in stove fronts and furnace peep-holes; whilst, on account of its extreme flatness, the brown mica of certain parts of Georgia makes the finest gramophone diaphragms. What is known as 'silver amber,' an altered form of phlogopite, is, on account of its softness, employed between the commutator segments of D.C. motors and dynamos. In a short paper on "Mica and its International Relationships," recently presented to the Institution of Mining and Metallurgy, Mr. G. V. Hobson has condensed an extraordinary amount of information on the production, distribution, and marketing of this mineral, leading up to a consideration of the international aspects of the industry, a subject of vital importance in war and becoming one of scarcely less significance in times of peace.

The Support of Coal Workings.—The sub-committee appointed to investigate methods of reducing the number of accidents due to falls of ground in the coal-mines of Great Britain has issued three reports—Papers Nos. 6, 12, and 30—of which the latter is now before us (Safety in Mines Research Board: The Support of Underground Workings in the East Midland Coalfield, Yorkshire, Derbyshire, excluding South Derbyshire, and Nottinghamshire. London: H.M.S.O.; 2*d*.). The committee is commencing by studying the methods of support used in the different coalfields of Great Britain and pointing out any features which they consider might be more generally adopted with advantage. Perhaps the most important recommendation in the present report is that which refers to the tubular steel prop largely adopted by the Butterley Company, Limited. It consists of a steel tube closed at the top, over which passes a sliding sleeve which can be kept in position by a bolt passing through a slot in the sleeve, whilst the upper part of the sleeve carries a wooden plug. When weight comes on, the wooden plug is crushed in the sleeve, which then slides over the tube, the length of slide which the construction admits of being about 6 inches. The prop can, of course, be used over again by inserting a fresh wooden plug. It is stated that where it is in use only one reportable accident, and that not fatal, due to a fall of roof, has occurred during more than a million man-shifts since the prop was introduced more than eight years ago. It is claimed that this prop keeps the roof in better condition, that it maintains roof height better than wooden props, occupies less space, is more durable, more economical, and easier to withdraw. The report emphasises the need of strict supervision and good discipline, and regrets that relatively little is being done in the matter of safety instruction. Finally, a set of model timbering rules is suggested. The modest price at which this paper is published is intended to bring it within the reach of all, and it is to be hoped that coal miners will take advantage of the information thus placed at their disposal.

Conduction of Electricity through Gases.—Prof. Seeliger's recent article in the *Zeitschrift fur Physik* (41, p. 535, 1927) illustrates how little is actually known about what takes place in a discharge-tube. His own intensity rule, for example, that the higher the energy required to excite a given line of the spectrum of the contained gas, the nearer does the region where its brightness is a maximum approach the cathode, still awaits an adequate explanation, in spite of its apparent simplicity. The number of electrons which leave the cathode for each positive ion received is uncertain, as well as the mode of conduction across the cathode dark space, and exactly how this is affected when the cathode is raised in temperature in order to lower the cathode fall of potential. It seems likewise impossible at present to reconcile the sharp cathode boundary of the negative glow formed in most cases, with the apparent continuity of the latter and the cathode dark space in pure inert gases. Prof. Seeliger is specially concerned with the origin of the visible radiation, which may be produced either as a result of the recombination of ions, or in the return to their normal state of neutral molecules excited by electron impact. Some conclusions can be drawn about the relative importance of the two processes in different parts of a tube, but even then difficulties arise from our meagre knowledge both of the relative numbers of free electrons and negatively charged molecules which are present, and of the nature of the radiation which results from recombination. Unfortunately, there is no immediate prospect of solution of most of these problems.

Magnesium-Copper Alloys.—A paper on "Magnesium-Copper Alloys rich in Magnesium" was read by Dr. M. Hansen at the recent meeting of the Institution of Metals. It is shown that magnesium is capable of holding copper in solid solution to the extent of about 0·1 per cent. at room temperature and about 0·4-0·5 per cent. at 485° C. It has not, however, been possible to detect any preceptible age-hardening in alloys quenched from 450° C. on standing at room temperatures. This appears to be due to the fact that, even on quenching, the compound is precipitated as microscopical particles, which coagulate as the rate of cooling becomes slower. This coagulation is accompanied by a slight decrease of hardness and a considerable increase of ductility. Ageing at high temperature results in no perceptible change in hardness.

Coal Carbonisation Retorts.—The Department of Scientific and Industrial Research has issued Fuel Research Technical Paper No. 17 (H.M.S.O., 6*d*. net) on "Low Temperature Carbonisation." It is of the nature of an interim report on the behaviour of vertical retorts erected at H.M. Fuel Research Station, Greenwich. These retorts are based in design on Scottish shale practice and are of grey cast iron, externally heated to 625° C. in a setting of very simple construction. They are 21 ft. high, of width tapering from 7 in. at the top to 11 in. at the bottom, and provided with mechanical extraction gear. The coal dispute of 1926 restricted the supplies and choice of coal, but results are given for tests on nine different samples. Non-caking nuts were the easiest to work, and gave the highest yield of tar and the greatest throughput. Caking coals received a preheating treatment which reduced trouble due to sticking. Fine coal was dealt with by briquetting. The 'E' retorts, which have been most successful, have been in use for the twelve months ending Dec. 27, 1926, for the carbonisation of 1350 tons of coal, and were then still fit for further service. With the collaboration of the Cast Iron Research Association, a new retort of special metal is under construction and will be tested alongside those referred to above.

Water Vapour in the Atmosphere.[1]

The Constitution of Fog and Cloud.

THE water in the atmosphere is responsible for practically all the variations which are classed as weather. The way in which it enters the atmosphere, the forms in which it is made visible, and the manner in which precipitation, whereby it leaves the atmosphere, is produced, must always be matters of fundamental importance to meteorology and matters which lend themselves most readily to methods of physical research.

The fact that water drops can be cooled below freezing point without solidifying, and that supercooled water drops can exist in the atmosphere, was demonstrated long ago by physicists like Jamin and by meteorologists like Assman. That, however, is not the end of the story, and Dr. Kohler has made full use of the opportunities which his position as director of the Halde Observatory provided, to investigate the matter further. This observatory is situated in the extreme north of Norway, at a height of about 3000 ft. above sea-level, and it experiences in the course of the year the full range of variation of temperature, wind, and weather. The results of researches made there in 1920–23 are published in a collected form in the memoir under notice.

The problem was attacked in two ways:

(1) By microscopic examination of the deposit from fog (or cloud) below freezing point;
(2) By an examination of coronæ sometimes round the sun or moon, but more frequently round an artificial source of light placed on the highest point of the Observatory and observed from a distance of about 70 yards.

From microscopic examination it was found that even down to temperatures of − 28° C., the drops in fog were spherical drops and not crystalline in form. Crystals which fell through the fog invariably had upon them numerous spherical drops which they had picked up in their passage. Though crystals might form on wires and plates exposed to the fog, they also invariably had spherical drops on them, and if the exposures were short enough, the first deposits were practically invariably drops and not crystals.

The observations of coronæ are divided broadly into three sections:

(1) Observations in fog at a temperature definitely above freezing point.
(2) Observations in fog at a temperature definitely below freezing point.
(3) Observations in clouds the temperature of which was not directly observed.

There are simple relations connecting the angular radii of the different rings of a corona formed by spherical drops, with the radius r of the drops themselves. They are:

$$\sin\theta_1 = \frac{1\,220\,\lambda}{2r},$$

$$\sin\theta_2 = \frac{2\,233\,\lambda}{2r},$$

where λ is the wave-length of the light used. If the corona were formed by long thin crystals instead of by spherical drops, the formulæ connecting the thickness b of the crystal with the angular radii of the rings would be different:

namely: $$\sin\theta'_1 = \frac{\lambda}{2b}, \qquad \sin\theta'_2 = \frac{2\lambda}{2b},$$

hence $$\frac{\sin\theta'_1}{\sin\theta'_2} = \frac{1}{2},$$

while $$\frac{\sin\theta_1}{\sin\theta_2} = \frac{1{\cdot}22}{2{\cdot}33}.$$

Measurements of θ_1, θ_2 therefore furnish a criterion for distinguishing between coronæ formed by drops and coronæ formed by crystals.

Dr. Kohler found from his measurements that the coronæ in fog were always caused by drops and not by crystals. One or two measurements appeared to be exceptions to the general rule, but these proved on closer examination to be due to special circumstances, such as rain falling at the time of measurement. Observations of coronæ in clouds of the cumulus, alto-cumulus, and strato-cumulus type showed that these clouds also consisted of drops and not crystals, at least on those occasions when they caused coronæ. Observations of coronæ in cirrus and alto-stratus cloud pointed, however, to a crystalline origin. Apart from the evidence of the relative magnitudes of θ_1, θ_2, it appeared that if the coronæ had been caused by drops, the drops must have been unusually and improbably large, considerably larger than the drops in fog at the level of the Observatory. Coronæ formed by these clouds appear, therefore, to be caused by ice crystals, a deduction supported by the fact that aviators find clouds of the alto-stratus type full of ice crystals, though they do not consist entirely of ice crystals. Some years ago, however, Dr. Simpson, in discussing observations of coronæ in the Antarctic, gave reasons for supposing that ice crystals in the atmosphere could not cause coronæ, and in a later section of his paper, Dr. Kohler runs away from the first and obvious deduction from his measurements and leans to the conclusion that in the alto-stratus and cirro-stratus clouds, the coronæ are caused by drops mixed with crystals. His reasons for rejecting the crystal hypothesis do not appear to be entirely conclusive, and the question whether coronæ are caused in some cases by crystals is still an open one.

Dr. Kohler found drops of different sizes in fogs; a fog causing coronæ did appear to be constituted for the moment of drops of similar size, but as the diameters of the coronæ changed it was evident that the radii of the drops also changed. When the results of some thousands of measurements were arranged according to the frequency of occurrence of drops of different sizes, the frequency distribution was not, as one might have expected *a priori*, according to the normal curve of errors, but maxima and minima occurred at those values which the radii of the drops would have if drops were made by the combination of two, four, eight, sixteen, etc., primal drops. If m were the mass of the primal drop, then the other drops had masses $2m$, $4m$, $8m$, $16m$, etc. Many years ago, Defant published some observations of the sizes of rain drops which pointed to a similar law, but the sizes of Defant's rain drops were 10-100 times the size of the drops in Dr. Kohler's fogs. It is difficult to see why an original set of drops of uniform size should be produced, but if a layer of such primal drops were formed, and these primal drops began to combine by two's, the resulting drops would fall through the atmosphere at a different rate from the primal drops. These combined drops would therefore have a bigger chance of meeting one another than of meeting a primal drop. There would be a tendency towards a greater production of drops consisting of 4 primal drops than of drops consisting of 3 primal drops, and the process would be extended to the next drops of 8 primal drops and so on. As regards the primal drops, Dr. Kohler found two sets with diameters in the neighbourhood of 7μ and 8μ respectively, but the 7μ group was far and away the most frequent.

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[1] "Untersuchungen uber die Elemente des Nebels und der Wolken" (Stockholm: Hilding Kohler, 1925.)

From an analysis of the rime deposited at the Halde Observatory from fog or cloud, Dr. Kohler found that the average amount of chlorine present was practically the same as the average amount found in rain water collected at Cirencester by Kinch. The actual amount present in samples of rime collected on different occasions varied very greatly. The average was about 3·5 milligrams per kilogram of rime, and the quantities on different occasions varied from 0·07 milligram to 56 milligrams. From an analysis of the results it was found that the same law existed among the chlorine amounts as among the sizes of the water drops; that is, amounts $\frac{1}{8}$, $\frac{1}{4}$, $\frac{1}{2}$, or 2, 4, 6, 8 times the average amount, 3·5 milligrams per kilogram, were found, but there were practically no intermediate amounts. Dr. Kohler considers that the nuclei of condensation are nuclei of salt carried into the atmosphere from the sea, and that these salt nuclei also follow the law of 2. The weight of the primal salt particle is computed to be $1·8879 \times 10^{-23}$ grams. Drops of water in the atmosphere are therefore really salt solutions of greater or less strength. The strength depends upon the water vapour pressure and the temperature of the air. If the vapour pressure falls or the temperature rises, water is evaporated from the drops until the solution becomes strong enough to be in equilibrium with its surroundings and vice versa. As the growth or decrease of drops by such processes is continuous, there ought to be drops of all sizes, which is contrary to the law of distribution of sizes of drops found in the earlier part of the paper.

The paper is full of interest. The observations collected in it are invaluable, and the information about the range of sizes of drops from about 4μ to 20μ is most important. Dr. Kohler has endeavoured to apply in statistical sense the criterion which he himself enunciates, that if meteorology is to exist as an exact science, it is necessary to be critical of hypotheses even when they appear to be more or less well founded; but nevertheless one feels that independent testimony—dare one hope, from Scotland—is required of the law of 2, both in the size of drops and in the amount of chlorine present, before it can be included among the established facts of meteorology.

E. Gold.

The Lunar Eclipses of 1927.

There are to be two lunar eclipses in 1927, about the middle and end of the year. Some of their relations to the earth's atmosphere are as follows:

June 15, 1927.—The first eclipse is at its height (mid-eclipse) at 8^h $24·2^m$, Universal Time, but the moon barely gets within the umbra on the north side of the earth's shadow. The radius of the geometrical umbra is 40′·8; the outer limb of the moon at mid-eclipse is distant 40′·7 from mid-shadow. At this moment the edge of the shadow nearest to the moon's limb is cast by the earth's surface and atmosphere at about W. 97°·3, N. 63°·75, in the neighbourhood of Baker Lake, which drains into Chesterfield Inlet, on the west shore of Hudson Bay. It would be interesting to know the weather, cloud, and sky conditions in this region at that moment. But the atlas indicates scarcely any population there.

In the eclipse of Nov. 4, 1892, the outer limb of the moon was 43′·0 from mid-shadow, the radius of the geometrical umbra was 45′·4, so that the immersion was deeper than in the coming case. But Gale, at Sydney, N.S.W., reported the limb so bright as to give the impression that the eclipse was not total; Russell, also at Sydney, said definitely that it was not total; Doberck, at Hong Kong, remarked on the brilliancy of the immersed limb. We may expect this time an opportunity to observe the density of the earth's shadow very near to the edge, but due to weather and climatic conditions very different from those which ruled in 1892. Then the grazing-point was over water, between Iceland and Norway, north of the Shetland Islands.

The last rays on the moon's limb at first contact with the umbra graze the earth's surface or atmosphere about W. 174°·7, N. 32°·7. This is at sunset on the open Pacific, north of Pearl and Hermes. The rays at last contact in like manner graze about W. 69°·1, N. 17°·6, a point at sunrise in the Caribbean Sea, considerably south of Catalina Island, south of Santo Domingo. Observations of weather, cloud, and sky at these points are desired, for comparison with direct observations of the shadow edge at these moments.

The two internal contacts at this eclipse come so close together that they are scarcely separable from mid-eclipse. At mid-eclipse the sunrise-sunset line, centred about the sub-solar point at E. 54°·0, N. 23°·3, passes by Cape San Roque, Nova Scotia, Great Slave Lake, New Guinea, Gulf of Carpentaria, and Enderby Land. Of all this great circle, however, only a fraction, perhaps 35°, on the two sides of the Baker Lake region, is effective in illuminating the eclipsed moon.

Dec. 8.—The second lunar eclipse, on Dec. 8, with middle at 17^h $34·6^m$, Universal Time, is of much deeper immersion, 11′ or more at most, in the southern half of the shadow. The inner (north) limb of the moon just covers the middle of the shadow. The grazing light at the contacts comes from regions about the points indicated:

First Contact; E. 41°·6, S. 25°·7, in the Mozambique Channel, between Tullear and Europa Island, at sunset.

Second Contact; E. 51°·0, S. 51°·3, in the Sea Tang, south of the Crozets, at sunset.

Third Contact; E. 164°·4, S. 22°·0, south-west of New Caledonia, at sunrise.

Fourth Contact; E. 157°·0, S. 3°·5, north-east of Bougainville Island, at sunrise.

Observations of weather, cloud, and sky at these points are desired, for comparison with observations of the shadow edge at the contacts.

At mid-eclipse the sunrise-sunset line is centred about the subsolar point at W. 85° 75, S. 22°·7, and passes over or near Kaiser Wilhelm Land, Fiji Islands, Sitka, Baffin Land, Cape Farewell, Timbuctoo, Mossamedes, Cape Town. The whole southern half of this great circle is effective in illuminating the eclipsed moon at this moment.

The mere naming of the grazing-points above indicates that observations within a few degrees of them are unlikely to be obtained. Still, it is desired that persons near any such, at sea or ashore, report their observations of weather, cloud, and sky at the sunrise or sunset moments indicated, either to a scientific journal or to the address, Lunar Eclipses, Harvard College Observatory, Cambridge, Mass., U.S.A.

University and Educational Intelligence.

Cambridge.—The Linacre Lecture will be delivered on Friday, May 6, by Dr. J. A. Murray, Director of the Imperial Cancer Research Fund, on the subject of "Multiple New Growths."

London.—Applications are invited (until July 1) for the Laura de Saliceto studentship, of the annual value of £150, for the advancement of cancer research; also (until June 15), for grants from the Thomas Smythe Hughes Fund for assisting medical research. The applications should be addressed to the Academic Registrar of the University, South Kensington.

Glasgow.—At the ceremony of graduation held on Saturday, April 23, the following University prizes, among others, were awarded: The Captain H. S. Ranken, V.C, Memorial Prize to the student who obtained the highest marks in the subject of pathology in the professional examinations held in the year 1926, to Andrew M. Wyllie; Thomson Prize in geography for an essay on "The Economic Geography of the Lanarkshire Coalfield," to David W. Cousin; Bellahouston Gold Medals for eminent merit in theses for M.D. to Dr. George M. Wishart and Dr. Donald M'Intyre; Struthers Gold Medal and Prize for research on "The Development of the Vascular System in the Human Ovum prior to the Establishment of the Heart," to Dr. Donald M'Intyre.

St. Andrews.—The University Court has appointed Dr. George J. Robertson, St. Andrews, to the lectureship in chemistry in the United College, vacant through the resignation of Dr. George MacOwan.

Dr. Peter G. Carter, of the Chemistry Research Laboratory, United College, University of St. Andrews, has been appointed to a lectureship in organic chemistry in the University of Sydney.

It is exactly two years since the Hebrew University of Jerusalem was inaugurated by Lord Balfour, and it is of considerable interest to examine the progress that has been made. An account of this progress is contained in a recent circular sent out by the Board of Governors. The work of the University is at present mainly directed towards research, and the lectures delivered are intended for graduate students. In the Institute of Jewish Studies and in the Arabic section of the School of Oriental Studies, a number of graduate courses are being delivered by twelve professors and lecturers. In the Institute of Chemistry, research workers are being trained, and many papers have been published. A Department of Hygiene has been organised to investigate problems in epidemiology. Important fundamental work has been carried out in the Department of Microbiology. An Institute of Palestine Natural History is being organised. Preparations are in hand for a Mathematics Department and for the erection of a Physics Department. Great progress has been made with the Library, which now has 140,000 volumes, and many valuable scientific collections have been acquired. The annual budget of the University is at present £35,000, and the academic staff numbers about fifty. Steps are being taken to widen the scope of the University, with special reference to the introduction of more extended teaching, and the consolidation of some of the chief departments and sub-faculties.

Calendar of Discovery and Invention.

May 1, 1843.—On this day was published the "Manual of British Botany," a work in which Charles Cardale Babington critically compared the native flora of Britain with continental plants.

May 1, 1866.—Recognised from the first as the leading meteorological journal of the world, the *Meteorologische Zeitschrift* was started by Julius Hann on May 1, 1866, and he continued to edit it with various colleagues until 1921. Its original name was the *Zeitschrift der Österreichischen Gesellschaft für Meteorologie*.

May 2, 1800.—Constructing a voltaic pile by the aid of the information in Volta's famous letter to Sir Joseph Banks in March 1800, Nicholson and Carlisle, on May 2, 1800, demonstrated that water could be split up into its constituent gases by the passage of a current of electricity. Their pile contained 36 half-crowns and 36 zinc discs.

May 3, 1715.—Down to the eighteenth century, accounts of total solar eclipses are meagre. That of May 3, 1715, was observed, however, by several astronomers in England, and Halley has left an interesting account of it. "I forbear to mention," he says, "the chill and damp which attended the darkness of this eclipse, of which most spectators were sensible and equally judges. Nor shall I trouble you with the concern that appeared in all sorts of animals, birds, beasts, and fishes, upon the extinction of the sun, since ourselves could not behold it without some sense of horror."

May 3, 1865.—While serving as a sergeant in the Garibaldean Wars of 1859, Pacinotti thought out the principle of the ring armature dynamo. He constructed such a machine in 1860, and described his invention on May 3, 1865, in the scientific journal *Il nuovo cimento* Gramme's re-invention of the ring armature in 1870 was done without any knowledge of the work of Pacinotti.

May 5, 1707.—In his "Memoirs," Whiston says: "Mr. Cotes and I began our first course of philosophical experiments at Cambridge, May 5, 1707. In the performance of which certain hydrostatick and pneumatick lectures were composed: they were in number twenty-four, the one-half by Mr. Cotes and the other half by myself, which lectures were afterwards made use of in the like (enlarged) course which Mr. Hauksbee and I performed many years in London."

May 6, 1845.—On this day Wheatstone and Cooke patented the single needle telegraph instrument which has remained in use for more than eighty years.

May 6, 1886.—One of the most important contributions to the study of dynamo design was the paper on dynamo-electric machinery by John and Edward Hopkinson, read to the Royal Society on May 6, 1886. The first part of the paper was devoted to the construction of a characteristic curve for a machine of given dimensions, and the second part to a description of actual experiments with a dynamo, which were carried out at the Salford Iron Works of Mather and Platt.

May 6, 1896.—Commencing his experiments on planes moving through the air in 1887, Langley showed that relatively little power was required to sustain a given weight if the horizontal velocity reached a certain speed. Putting his ideas into practice, he made a steam-driven model aeroplane weighing about 25 pounds, which on May 6, 1896, at Quantico, Virginia, flew for about 1000 yards.

E. C. S.

Societies and Academies.

London.

British Mycological Society, Mar. 19.—**W. R. I. Cook**: Influence of environment on *Ligniera Junci*. Examination of natural habitats shows that slightly acid water with excess of iron favours growth of the fungus. Laboratory experiments show that light is a more important factor in determining infection, as when exposed to light, roots are not infected and any existing infection disappears.—**Miss M. P. Hall**: Zonation in cultures of *Monilia fructigena*. Cultures show concentric bands of sterile mycelium with bands of conidia, which are controlled by the medium. The initial reaction should be acid unless growth induces acidity, and the concentration should not cause staling. Conidia are produced in light but not in darkness. Zonation can also be produced by temperature variation.—**K. R. Mohendra**: Variation in *Sphæropsis Malorum*. Spores from a single pycnidium of a strain of *S. Malorum* gave two kinds of cultures, black and white. The ratio between the two was not constant, the whites increasing from three to one until the blacks had almost gone. Spores from a single white pycnidium gave white individuals only: spores from single black pycnidium gave mainly black but also a few white. The percentage of white colonies could be increased by repeated culture, but one strain gave only black individuals. White strains show a considerable amount of variation in spore formation.—**E. Wyllie Fenton**: Seed mixtures and incidence of fungal diseases. Plots grazed and mown for hay were sown with different seed mixtures. One of the grazed plots and all the hay plots were yellow with *Uromyces Dactylidis*. Absence of a reasonable amount of clover deprived the grasses of a sufficient supply of nitrogen.—**E. H. Ellis**: Fungi in Japanese carvings. An account of the fungi conventionalised in Japanese netsukes.

Physical Society, Mar. 25.—**E. Mallett**: Acoustical experiments with a mechanical vibrator. Preliminary experiments are described with a mechanical device vibrating a piston at one end of a tube so that a sound wave is emitted at the other. The particle velocities in the sound wave are measured by a Rayleigh disc, and resonance curves are drawn. The energy in the sound wave can be calculated from the results. The experiments are directed towards obtaining a standard source of sound, and the results are encouraging.—**E. T. Paris**: On the stationary-wave method of measuring sound-absorption at normal incidence. The apparatus differs from that used by earlier workers in the use of (1) a small tuned hot-wire microphone for determining relative pressure-amplitudes in the sound-waves; (2) the employment of a steady valve-driven source of sound with arrangements for maintaining the strength at a constant value; (3) the screening of source and experimental pipe from disturbances due to the movements of the observer. The relation between the response of the microphone and the amplitude of the pressure-variation in the sound-wave is eliminated.—**J. H. Awbery** and **Ezer Griffiths**: A ball and tube flowmeter suitable for pressure circuits. This robust form of the Ewing ball and tube flowmeter is suitable for the metering of gases or liquids under pressure, as for example the ammonia in a refrigerating plant. The necessary pressure-tight joints for connecting the conical tube to the circuit are described, and also a device for cutting off the flow should the tube fail.

Optical Society, April 7.—**C. V. Raman**: Huyghens' principle and the phenomena of total reflection. The phenomena of total reflection are considered *de novo* from the viewpoint of the principle of Huyghens, which enables us to evaluate the disturbance appearing in the second medium when light is incident on the boundary between two media and is totally reflected into the first medium. The disturbance takes the form of a superficial wave moving parallel to the boundary and involves an acceleration of the reflected wave with reference to the incident wave, which is zero at critical incidence. The intensity of the superficial wave at critical incidence is greater for the component having the magnetic vector parallel to the surface, but diminishes more rapidly with increasing incidence than for the component having the electric vector parallel to the surface. The phase angle between the two components is an *acute* angle, in agreement with the classical treatment based on the Fresnel formulæ, but in disagreement with the conclusions of Lord Kelvin and Schuster.—**H. W. Lee**: The Hartmann formula for the dispersion of glass. The Hartmann formula is accurate within the limits of the Pulfrich refractometer. Optical glasses can be divided into three well-marked classes by their Hartmann constants, with linear relations between the constants in each class.

Cambridge.

Philosophical Society, Mar. 14.—**G. I. Taylor**: An experiment on the stability of superposed streams of fluid. Experiment to illustrate the stabilising effect of a density distribution similar to that which occurs in the air near the ground on a cold clear night. A stream of water flows over a coloured solution of salt. Instability sets in when the upper stream attains a certain velocity.—**C. D. Ellis** and **W. A. Wooster**: The absolute intensities of the γ-rays of radium-B and radium-C. The measured intensities of the groups in the β-ray spectra of these bodies, due to the internal conversion of the γ-rays in the atom that emits them, are used. The magnitude and rate of variation with frequency of the internal conversion coefficient is determined by considering the total energy and total number of the emitted γ-rays, both of which have been measured. To account for the measurements the internal conversion coefficient must vary approximately as the inverse 2·65th power of the frequency and have a value of 0·12 at a frequency corresponding to $3 \cdot 54 \times 10^6$ volts. This result strengthens the evidence for physical reality of internal conversion. Using this co-efficient the intensities of the γ-rays are obtained directly from the intensities of the β-ray lines. One striking result is the amount of energy concentrated in the high frequencies.—**P. M. S. Blackett**: The limits of classical scattering. The condition given by de Broglie for the validity of geometrical optics is applied to the waves associated with a material particle; in particular to find the limits of classical scattering of α-particles by nuclei.—**J. A. Gaunt**: The stopping power of hydrogen atoms for α-particles according to the new mechanics. The classical theory of the stopping of α-particles agrees well with experiment, when account is taken of the transfer of energy to atoms at a considerable distance from the track. The limitations imposed by the stationary states of the old quantum theory seriously diminish the effect of the less close encounters. The new mechanics avoids this starvation of the more distant atoms. The deflexion of the α-particle is neglected. The excitation and ionisation of atoms at distances from the track, which are large in comparison with atomic dimensions, are calculated approximately by perturbation theory. The transfer of energy is nearly the same as on the classical theory.

Dublin.

Royal Dublin Society, Mar. 22.—**L. B. Smyth**: The index fossil of the Cleistopora zone. New material from Hook Head, Co. Wexford, together with a re-examination of the S.-W. Province specimens, shows that this is not a Cleistopora. It has a compact, fibrous coenenchyma, and a system of ring canals, and is therefore placed in Vaughania Garwood. M'Coy's *Astreopora antiqua* is considered, and the specific name rejected. The name *Vaughania vetus* is proposed. A portion of its ontogeny is worked out.—**Dorothy Beckett**: The influence of separation and pasteurisation on the size and distribution of fat globules in milk and cream. By direct measurement and counting on photographs at magnifications of 250 and 500 of samples of milk, in which the average diameter of globule was 3·7μ, and those larger than 6μ contained 9 per cent. of the fat, it was found that the distribution of the smaller globules was unchanged by the creamery process, but in the final cream 36 per cent. of fat was contained in globules ranging from 6μ to 24μ.—**H. H. Poole**: A convenient method of charging electroscopes. A well-insulated variable air condenser of capacity about 0·001μ *F*., as used in radio reception, is set to its maximum capacity and charged from a battery or D.C. mains. It is then connected to the gold leaf, and by reducing the capacity the potential is raised to any desired voltage within the limit imposed by internal sparking. Initial voltages of either 80 or 220 were found to work well with the electroscope used, which, having a relatively heavy gold leaf, requires a large charging potential. Lower initial potentials could probably be used with many electroscopes, especially if a 'square law' condenser were used.

Royal Irish Academy, April 11.—**J. L. Synge**: Mathematical investigation of the thrust experienced by a cylinder of any section in a current of inviscid liquid, the motion being periodic and a regular train of vortices being formed. The formula obtained differs from that of Kármán, which only contains the first term. (2) Time measurement in an isotropic space-frame. The transitivity of simultaneity (if *A* is simultaneous to *B* and *B* is simultaneous to *C*, then *A* is simultaneous to *C*) is here proved on the simple assumption that the space-frame is isotropic with respect to light propagation.

Paris.

Academy of Sciences, Mar. 21.—**C. Matignon** and **Mlle. G. Marchal**. The reducing properties of beryllium. The isolation of barium, magnesium, potassium, and aluminium. At a temperature of 1200°-1300° C., *in vacuo*, beryllium gives no appreciable amount of vapour, and this, with its high heat of combustion in oxygen, renders this metal a valuable reducing agent. Details are given of the reduction of baryta to barium, magnesia to magnesium, potash to potassium, and alumina to aluminium. Lime is converted under the same conditions into calcium suboxide.—**Pierre Termier**: The tectonic problem of Vanoise and Mont-Pourri (Savoy Alps).—**André Blondel**: Rotating radiophares. A method for supplementing or replacing lighthouses by radio signal stations.—**Léon Guillet** and **Albert Roux**: The gases contained in brass, aluminium, and its alloys. Brass gives from 0·4 to 0·55 of its volume of gases (carbon dioxide and monoxide, hydrogen and nitrogen). Aluminium gave 0·14 of its volume of gas (carbon dioxide and monoxide and hydrogen).—**Beniamino Segre**: The cubic indicator of the linear projective element of a surface.—**Pierre Humbert**: Differential equations which generalise Lamé's equation.—**Octave Onicescu**: The representation of a function by an ensemble of functions and the integral equations which result.—**W. Margoulis**: New experimental researches on the helices of helicopters.—**P. Dejean**: Hardening by traction, hardening by compression.—**R. Wavre**: The stratification of the planets in surfaces of equal density.—**H. André**: The electrical properties of some metallic compounds. Silver sulphide is capable of absorbing a certain quantity of sulphur at a low temperature. This mixture has an electrical conductivity which diminishes with rise of temperature, and is susceptible of numerous industrial applications.—**Vaulot**: The constants of a passive quadripole.—**Léon** and **Eugène Bloch**: The fluorescence of chlorine and bromine.—**E. Doumer**: The electrolysis of aqueous solutions of pure oxalic acid. A mixture of carbon dioxide and oxygen is evolved at the anode, the proportion varying with the current density.—**H. Colin** and **Mlle. A. Chaudun**: Mutarotation and the alkalinity of the medium. The action of soda and of ammonia on the change in rotation of glucose are parallel down to a concentration of *N*/5500.—**W. Ipatief** and **Orloff**: The hydrogenation of dibenzalacetone and of dibenzylacetone.—**Roger Lyon**, **G. Fron**, and **M. Fournier**: The characterisation of old wood as compared with green wood. Old stored wood has a different composition from new wood of the same species. This difference can be detected by microscopical observation or by measuring the hydrogen ion concentration of the water soluble extract.—**Const. A. Kténas**: Discovery of the lower marine Pliocene in the island of Nikaria (Egean Sea).—**P. Martens**: Vital observation of karyokinesis.—**Henri Coupin**: The influence of calcium on *Penicillium glaucum*. It is inexact to say that calcium is useless to *P. glaucum*, since its presence is necessary to the good formation of the conidia.—**E. Miège**: Sudden appearance of a barley with smooth beard.—**Robert Lami**: The liberation, following traumatism, of fungoid symbiosis of the young plants of Cattleyeæ.—**J. Dumont**: The weight ratios of the reacting bodies in colloidal flocculations.—**D. Bach**: The nitrogen nutrition in the Mucorineæ. The assimilation of ammoniacal salts.—**L. Ambard** and **F. Schmid**: The excitability of the nerve centres as a function of their charge of hydrochloric acid.—**Ch. Achard**, **Léon Binet**, and **A. Leblanc**: Death in a superoxygenated atmosphere. An excess of oxygen over the normal atmospheric proportion causes death in animals. It is concluded that inhalations of pure oxygen used in therapeutics should not be too prolonged.—**Charles Richet**: Observations on the preceding communication. The author's observations made in 1904 confirm the conclusions given in the preceding paper. The composition of the atmosphere is an optimum for living beings and any change in either direction is disadvantageous.—**Raymond-Hamet**: The antagonism of hydrastinine and adrenaline.—**J. Chevalier** and **Ripert**: The pharmacodynamic action and physiological titration of preparations of flowers of pyrethrum.—**E. Grynfeltt** and **H. J. Guibert**: The genesis of the fibroid weft of cicatricial tissue in experimental suppurations of the subcutaneous conjunctive.—**Alfred Maubert**: The influence of thorium-X on laccase. In doses between 1 and 5 micrograms, thorium-X causes an activation of laccase: in quantities of more than 10 micrograms, complete inactivation of the ferment is produced.—**C. Levaditi**: The sterilising action of bismuth in syphilis.—**E. Ducloux** and **Mlle. G. Cordier**: A method of immunisation by slow resorption of virulent antigens.

VIENNA.

Academy of Sciences, Feb. 24.—J. Hertzka: Relations between the fundamental chemical numbers.—D. Balarew: The equilibria between the hydrates of calcium sulphate.—T. Radakovic: The interpolation of functions of several variables.—F. Emich: The observation of 'streaks' (*Schlieren*) in chemical experiments. Toepler showed that the observation of flaws was one of the most sensitive methods in optics. This method is applied to testing with the microscope the purity and identity of small quantities of fluid distillates.—F. Trauth: Geology of the northern Radstadter Tauern and of their foot-hills.

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, Vol. 13, No. 1, January).—George B. Kistiakowsky: The activation of gases by adsorption. Measurements were made in a glass vacuum calorimeter of the heats of adsorption of hydrogen on a copper catalyst, before and after poisoning by oxygen, and of carbon monoxide on the active catalyst. Some of the adsorbed gas appears to be activated by the fields of force surrounding unsaturated surface atoms; oxygen oxidises preferentially the most unsaturated surface atoms.—D. H. Kabakjian: Luminescence due to radioactivity. Three types of such luminescence exist. The first, shown by synthetic zinc sulphide under the action of α-rays after an equilibrium condition is reached, may be due to the destruction and re-formation of active centres in the substance. The second is shown by pure radium or radium bromide; the substance shows luminescence after heating. Certain stable molecular configurations are formed at high temperature and persist on cooling until attacked by an α-particle. The third type, thermo-luminescence, is shown by fluorite crystal. Energy is furnished by α-, β- or γ-rays and set free by molecular agitation in the crystal. The lower the temperature the more energy is absorbed, and heating the crystal afterwards intensifies the luminescence.—J. C. Slater: Radiation and absorption on Schrödinger's theory.—Carl R. Doering: The death rate from diphtheria in Massachusetts for 51 years, 1875–1925. In 1875 the death rate was nearly 200 per 100,000 of population: since then there has been a steady rate of decline of about 5·5 per cent. per annum. Figures for New York show a similar decline. The highest rates of decline (1892–1908) occur when the use of antitoxin and bacteriological diagnosis were spreading, but the figures are only doubtfully significant statistically.—Edward L. Thorndike: A fundamental theorem in modifiability. If a certain situation promotes one of a number of responses, the frequency of the use of one 'connexion' causing a certain response does not increase its strength at the expense of other 'connexions' causing different responses. Facilitation and inhibition among the 'connexions' from a situation cannot be explained by 'a drainage theory' towards the stronger 'connexion.'—N. D. M. Hirsch: A summary of some of the results from an experimental study of the East Kentucky mountaineers.—George H. Shull: Crossing over in the third linkage group of Œnothera. The gene for double flowers (mut. *supplena*) in *Œ. Lamarckiana* is closely linked with that for old-gold colour (mut. *vetaurea*); the crossing-over observed is considered to consist in the exchange of factors between the two chromosomes of the same pair.—G. A. Miller: Groups generated by two operators of order three whose product is of order three.

Official Publications Received.

BRITISH.

Papers and Proceedings of the Royal Society of Tasmania for the Year 1926. Pp. iv+196+11 plates (Hobart: Tasmanian Museum.) 10s.

Union of South Africa: Department of Agriculture. Science Bulletin No. 52: Cost of Production of Maize; Report on the Investigation for the Season 1923–24. By D. W. McKellar. Pp. 24. 3d. Science Bulletin No. 58. The Manufacture of Loaf and Blended Varieties of Cheese. By Prof. H. B. Davel and D. J. Retief. Pp. 20. 3d. (Pretoria: Government Printing and Stationery Office.)

Aeronautical Research Committee: Reports and Memoranda. No 1060 (Ae. 243): Flying Positions of Control Surfaces of Bristol Fighter. By Capt. G. T. R. Hill. (A.2.b. Stability, Full Scale Expts., 40.—T. 2265.) Pp. 5+6 plates. 6d. net. No 1068 (Ae. 250): The Full Scale Determination of the Lateral Resistance Derivatives of a Bristol Fighter Aeroplane. Part ii: The Determination of the Rate of Turn Derivatives. By H. M. Garner. (A.2.b. Stability, Full Scale Expts., 42.—T. 2340.) Pp. 4. 3d. net. (London: H.M. Stationery Office.)

Empire Cotton Growing Corporation. Report on the Characteristics of Several Crops that may be suitable as Rotation Crops with Cotton in East Africa and the Possibilities of Marketing Them in this Country. By H. C. Sampson. Pp. 23. (London: Empire Cotton Growing Corporation.) 1s.

The Journal of the Institution of Electrical Engineers. Edited by P. F. Rowell. Vol. 65, No. 364, April. Pp. 389-463+xxx. (London: E. and F. N. Spon, Ltd.) 10s. 6d.

The Carnegie United Kingdom Trust. Thirteenth Annual Report (for the Year ending 31st December 1926) submitted by the Executive Committee to the Trustees on Friday, 11th March 1927. Pp. ii+110. (Dunfermline.)

The South African Journal of Science. Vol. 23: Being the Report of the Twenty-fourth Annual Meeting of the South African Association for the Advancement of Science, Pretoria, 1926, July 5-10. Pp. xliv+1150. (Johannesburg.) 35s. net.

Board of Education. Vacation Courses in England and Wales, 1927. Pp. 21. (London: H.M. Stationery Office.) 6d. net.

Journal of the Society of Glass Technology. Vol 11, No 41, March. Pp. x+11+97+124+xxxii. (Sheffield: The University.) 10s. 6d.

Royal Botanic Gardens, Kew. Bulletin of Miscellaneous Information, 1926. Pp. iv+496+90+11 plates. (London: H.M. Stationery Office.) 15s. net.

Aeronautical Research Committee: Reports and Memoranda. No 1057: On the Calculation of Stresses in the Hulls of Rigid Airships. By R. V. Southwell. (R. 38 Memorial Prize Essay, 1926.) Pp. 49. (London: H.M. Stationery Office.) 1s. 9d.

Leeds University: Department of Pathology and Bacteriology. Annual Report, 1926, by Prof. Matthew J. Stewart and Prof. J. W. McLeod. Pp. 12. (Leeds.)

FOREIGN.

Proceedings of the United States National Museum. Vol. 69, Art. 16: A Revision of the Parasitic Wasps of the Subfamily Braconinae occurring in America north of Mexico. By C. F. W. Muesebeck. (No 2642.) Pp. 73+2 plates. Vol. 70, Art. 18: Contribution to the Anatomy of the Chinese Finless Porpoise, *Neomeris phocaenoides*. By A. Brazier Howell. (No 2642.) Pp 43+1 plate. Vol. 70, Art. 16: Foraminifera of the Genus Ehrenbergina and its Species. By Joseph A. Cushman. (No. 2665.) Pp. 8+2 plates. Vol. 70, Art. 20: The Occurrence and Properties of Chlorophoenicite, a new Arsenate from Franklin, New Jersey. By William F. Foshag, Harry M. Berman and Robert B. Gage. (No 2669.) Pp 6. Vol. 71, Art 2: The Beetles of the Family Cleridae collected on the Mulford Biological Exploration of the Amazon Basin 1921–1922. By Edward A. Chapin. (No. 2674.) Pp. 10. (Washington, D.C.: Government Printing Office.)

Publications of the Kapteyn Astronomical Laboratory at Groningen. Edited by Prof. Dr. P. J. van Rhijn. No. 41: The Proper Motion and the Distance of the Praesepe Cluster. By Dr. W. J. Klein Wassink. Pp. 48. (Groningen: Hoitsema Bros.)

Journal of the College of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol. 18, Part 4: The Ticks Parasitic on Cattle and Horses in Hokkaido, Japan. By Kinjiro Ogura and Koji Takada. Pp. 199+206+plates 11-15. (Sapporo.)

Contributions to Embryology. Vol. 18, Nos 90-97. No. 90: Cultivation of Embryonic Heart Muscle, by Warren H. Lewis; No. 91: Correlation of External Genitalia and Sex-Glands in the Human Embryo, by Karl M. Wilson; No 92. The "Miller" Ovum—the Youngest Normal Human Embryo thus far Known, by George L. Streeter; No 93. Detailed Form of the Wolffian Body in Human Embryos of the First Eight Weeks, by Jujiro Shikinami; No. 94: Lens Ectoderm and Optic Vesicles in Allantois Grafts, by Vera Danchakoff; No 95: Menstrual Records and Vaginal Smears in a Selected Group of Normal Women, by Jessie L. King; No. 96: Transformation of Mononuclear Blood-Cells into Macrophages, Epithelioid Cells and Giant Cells in Hanging-Drop Blood-Cultures from Lower Vertebrates; by Margaret R. Lewis and Warren H. Lewis; No 97: Origin of Thrombocytes and of the Different Types of Blood-Cells as seen in the Living Chick Blastoderm, by S. Sugiyama. (Publication No. 366.) Pp. iii+147+49 plates. (Washington, D.C.: Carnegie Institution.) 5.75 dollars.

Anatomical Texts of the Earlier Middle Ages. A Study in the Transmission of Culture. By Prof. George W. Corner. With a revised Latin Text of *Anatomia Cophonis* and Translations of Four Texts. (Publication No. 364.) Pp. 112+8 plates. (Washington, D.C.: Carnegie Institution.)

Environment of Tetrapod Life in the late Paleozoic of Regions other than North America. By E. C. Case. (Publication No 375.) Pp. iii+211. (Washington, D.C.: Carnegie Institution.) 2.50 dollars.

Bulletin of the Geological Institution of the University of Upsala. Founded by Hj. Sjögren. Vol 20. Pp. 256+6 plates. (Upsala: Almquist & Wiksells Boktryckeri A.-B.)

Department of the Interior: Bureau of Education. Bulletin, 1927, No. 1: Educational Directory, 1927. Pp. iii+189. (Washington, D.C.: Government Printing Office.) 20 cents.

Abisko Naturvetenskapliga Station. Observations météorologiques à Abisko en 1915. Rédigées par Bruno Rolf. Pp. ii+76. (Stockholm: Almquist and Wiksells Boktryckeri A.-B.)

Catalogues.

Catalogue of Scientific Books and Publications of Learned Societies; including a Selection from the Library of Prof. Alfred Denny. No. 234. Pp. 32. (Cambridge: W. Heffer and Sons, Ltd.)

Bulletin No. 81: The New "Sunic" Flat Potter-Bucky Diaphragm. Pp. 4. (London: Watson and Sons (Electro-Medical), Ltd.)

Diary of Societies.

SATURDAY, April 30.

British Psychological Society (General Section) (jointly with the Cambridge Psychological Society) (at the Psychological Laboratory, Cambridge), at 2.30.—Prof. A. Michotte: Experiments on Learning to Perform Skilled Movements.—At 4.—Demonstrations: The Study of Long Spells of Repetition of a Skilled Task, Miss K. Pollock; An Experiment in Divided Attention, Miss E. J. Lindgren; Peripheral Visual Perception, M. Soloman; Learning to Perform Movements, Miss Blair and Miss Davis; Experiments on Reading, R. W. Pickford; Real and Illusory Visual Movements, Dr. H. de Silva; Constructive Imagination, Dr. E. Hutchinson; The Visual Effects of Flicker, Dr. Buchanan; Apparatus for the Study of Motor Elements of Skill in Shooting, Dr. Bannister; Plateaux in a Learning Curve, Mrs. Drury Smith; Localisation of Sound, P. Vernon.—At 5.45.—Symposium on The Relevance of Visual Images to the Process of Thinking—Prof. T. H. Pear, Dr. F. Aveling, F. C. Bartlett.

North of England Institute of Mining and Mechanical Engineers (at Neville Hall, Newcastle-upon-Tyne), at 3.—W. S. Rider: Feeding and Treatment of Animals below Ground and Stabling.—Paper open for further discussion: The Ventilation of a Pyrites Mine, with special reference to Fire-fighting, Safety, and Rescue Work, R. White.

MONDAY, May 2.

Cambridge Philosophical Society (in the Museums, Cambridge), at 4.30.

Royal Institution of Great Britain, at 5.—Annual Meeting.

Society of Engineers (at Geological Society), at 5.30.—C. Brunler: The Internal Combustion Boiler (Brunler Flame).

Royal Society of Arts, at 8.—J. W. T. Walsh: The Measurement of Light (Cantor Lectures) (2).

Society of Chemical Industry (London Section) (Annual Meeting) (at Chemical Society), at 8.—F. Tattersfield and C. T. Gimingham: Recent Investigations on Contact Insecticides.

TUESDAY, May 3.

Royal College of Physicians of London, at 5.—Dr. C. Gordon Douglas: The Co-ordination of the Respiration and Circulation with Variations in Bodily Activity (Oliver-Sharpey Lectures) (1).

Royal Society of Medicine (Orthopaedics Section), at 5.30.—Annual General Meeting.

Institution of Civil Engineers, at 6.—Prof. H. C. H. Carpenter: Some Recent Services of Metallurgy to Engineering (James Forrest Lecture).

London Natural History Society (at Winchester House, E.C.), at 6.—F. Martin Duncan: The Lore of the Bee.

Royal Photographic Society of Great Britain, at 7.—F. J. Hargreaves: Amateur Astronomical Photography.

Röntgen Society (at British Institute of Radiology), at 8.15.

WEDNESDAY, May 4.

Royal Society of Medicine (Tropical Diseases and Parasitology Section), at 5.30.—Annual General Meeting.

Institution of Electrical Engineers (Wireless Section), at 6.—C. F. Elwell: The Holweck Demountable Type Valve.—H. Morris-Airey, G. Shearing, and H. G. Hughes: Silica Valves in Wireless Telegraphy.—W. J. Picken: Cooled-Anode Valves, and Lives of Transmitting Valves.

Society of Public Analysts and other Analytical Chemists (at Chemical Society), at 8.—Dr. W. R. Schoeller and C. Jahn: Investigations into the Analytical Chemistry of Tantalum, Niobium, and their Mineral Associates. VII. The Precipitation of Tungstic Acid by Tannin. VIII. The Separation of Tungsten from Tantalum and Niobium.—S. G. Clarke: The Separation of Vanadium and Tungsten.—J. M. Jones and T. McLachlan: The Determination of Moisture by the Volatile Solvent Method.—F. Wokes and Dr. S. G. Willimott: A Study of Antimony Trichloride as a possible Quantitative Reagent for Vitamin A.

Royal Society of Arts, at 8.—Prof. W. E. Dalby: English Railways (Dr. Mann Lectures) (1).

Entomological Society of London, at 8.

Eugenics Society, at 8.

Folk-Lore Society (at University College), at 8.—Mrs. Murgoci: Vampires in Roumania.

THURSDAY, May 5.

Iron and Steel Institute (Annual Meeting) (at Institution of Civil Engineers), at 10 a.m.—Presentation of Bessemer Gold Medals to A. Wahlberg and Prof. C. Benedicks.—F. W. Harbord: Presidential Address.—J. Seigle: Some Aspects of the Technical and Economic Conditions of the Heavy Metallurgical Industry of the East of France, with Particular Reference to the Utilisation of Gases and Motive Power.—Prof. W. A. Bone, L. Reeve, and H. L. Saunders: An Experimental Inquiry into the Interactions of Gases and Ore in the Blast-Furnace.—At 2.30.—Sir Robert Hadfield: (*a*) The Metal Manganese and its Properties; Also the Production of Ferro-Manganese and its History; (*b*) Low-Carbon Alloys of Iron and Manganese.—Alloys of Iron Research. Part V. Introductory, Dr. W. Rosenhain. Preparation of Pure Chromium, F. Adcock. Part VI. Preparation of Pure Manganese, Marie L. V. Gayler. Part VII. Preparation of High Purity Silicon, N. P. Tucker.—Part VIII. The Constitution of Alloys of Iron and Phosphorus, J. L. Haughton.

Royal College of Physicians of London, at 5.—Dr. C. Gordon Douglas: The Co-ordination of the Respiration and Circulation with Variations in Bodily Activity (Oliver-Sharpey Lectures) (2).

Institution of Electrical Engineers, at 6.—Annual General Meeting.

Chemical Society, at 8.—W. Hanhart and Dr. C. K. Ingold: The Nature of the Alternating Effect in Carbon Chains. Part XVIII. Mechanism of Exhaustive Methylation and its Relation to Anomalous Hydrolysis.—H. Bassett and R. G. Durrant: The Interrelationships of the Sulphur Acids.

FRIDAY, May 6.

Iron and Steel Institute (Annual Meeting) (at Institution of Civil Engineers), at 10 a.m.—E. A. Atkins: The Drawing of Steel Wire and its Relation to Qualities of Steel.—Dr. W. H. Hatfield: Heat-Resisting Steels.—Prof. C. A. Edwards and J. C. Jones: The Influence of Annealing Temperature on the Properties of Mild Steel Sheets.—T. Swinden and G. R. Bolsover: Some Notes on Cold-Rolled Strip Steel.—B. Yaneske: The Manufacture of Steel in India by the Duplex Process.—At 2.30.—Prof. C. Benedicks and H. Löfquist: Theory of the Growth of Cast Iron Repeatedly Heated.—J. H. Andrew and H. A. Dickie: The Ac_1 Range in Special Steels.—J. H. Andrew, M. S. Fisher, and J. M. Robertson: The Properties of Some Nickel-Chromium-Molybdenum Steels.—Prof. K. Honda and K. Takahasi: A Further Investigation of the Indentation Hardness of Metals.—T. Matsushita and K. Nagasawa: The Phenomenon of Temper-Hardening in Steels.—S. Tamura: Notes on Pseudo Twinning in Ferrite, and on the Solubility of Carbon in Alpha Iron at the A_1 Point.

Royal Society of Arts (Indian Section), at 4.30.—B. C. Allen: Assam.

Royal Astronomical Society (Geophysical Discussion on Latitude Observations), at 5.—Chairman: Prof. A. S. Eddington. Speakers: P. H. Wade, Dr. J. Jackson, and others.

Royal Society of Medicine (Laryngology Section), at 5.—Annual General Meeting.

Royal Photographic Society of Great Britain, at 7.—Pictorial Group Meeting.

Photomicrographic Society (at 4 Fetter Lane, E.C.), at 7.—Annual General Meeting and Members' Evening.

Junior Institution of Engineers, at 7.30.—W. A. Sallis: Durham Bursar's Paper.

Geologists' Association (at University College), at 7.30.—L. J. Chubb: The Geological Work of the St. George Expedition to the Pacific Ocean.—H. B. Milner, A. J. Bull, G. S. Sweeting, and F. B. Eames: The Geology of South-East Sussex.

Society of Chemical Industry (Chemical Engineering Group) (Annual General Meeting) (at Imperial College of Technology), at 8.—Dr. W. R. Ormandy: Chemical Fire Extinguishers.

Philological Society (Anniversary Meeting) (at University College), at 8.—E. Arend-Chomski: The Inter-Verbal Phonetics of Cursor Mundi.

Royal Society of Medicine (Anaesthetics Section), at 8.30.—Annual General Meeting.

Royal Institution of Great Britain, at 9.—Major A. Corbett-Smith: China and the Real Chinese.

SATURDAY, May 7.

Royal Society of Medicine (Otology Section), at 10.30 a.m.—Annual General Meeting.

PUBLIC LECTURES.

SUNDAY, May 1.

Guildhouse (Eccleston Square S.W.), at 3.30.—R. A. Smith: Religion in the Late Stone and Bronze Ages.

MONDAY, May 2.

University College, at 5.30.—Prof. R. W. Chambers: Philology at University College.

TUESDAY, May 3.

University College, at 4.30.—Prof. J. S. B. Stopford: Sensation and the Sensory Pathway. (Succeeding Lectures on May 4 and 6.)

King's College, at 5.—Prof. R. J. S. McDowall: Autonomic Nervous System. (Succeeding Lectures on May 10, 17, and 24.)

Medical Society of London, at 5.15.—Sir Thomas Legge: The Teaching of Industrial Medicine (Chadwick Lecture).

Gresham College, at 6.—W. H. Wagstaff: Geometry. (Succeeding Lectures on May 4, 5, and 6.)

WEDNESDAY, May 4.

Royal College of Science, at 5.—Dr. P. Chalmers Mitchell: Logic and Law in Biology (Huxley Memorial Lecture).

THURSDAY, May 5.

Institute of Pathology and Research, St. Mary's Hospital, at 5.—Prof. C. Prausnitz: Experimental Researches on the Nature of the Bacteriophage.

SATURDAY, MAY 7, 1927.

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Co-operation in Research throughout the British Empire.

ONE of the most useful discussions at the Congress of the Universities of the Empire held at Cambridge last year, the official Report[1] of which has been published, was on "Co-operation in Research throughout the Empire." The subject is so attractive and appropriate to the times in which we are living that one may be pardoned for overlooking how modern is the idea of co-operation in the field of scientific research. Diogenes living in his tub, and asking nothing of the kings and satraps of the world except to get out of the sunlight, represents the traditional conception of a philosopher. Newman, in the preface to his "Discourses on the Scope and Nature of University Education," insists on the necessary solitude of the scientific investigator. "The common sense of mankind," he says, "has associated the search after truth with seclusion and quiet." The greatest thinkers are men of absent minds and idiosyncratic habits. Pythagoras lived for a time in a cave; Thales refused the invitation of princes. Friar Bacon lived in his tower upon the Isis; Newton in an intense severity of meditation which almost shook his reason. Who among his contemporaries, we may well ask, could claim to share the labours

> "Of Newton, with his prism and silent face,
> The marble index of a mind for ever
> Voyaging through strange seas of Thought, alone"?

In Newman's opinion, to discover and to teach are distinct gifts, not commonly found in the same person. This idea may explain the tentative way in which the teaching universities of Great Britain took up the work of scientific research. In Victorian Oxford, the Rev. C. L. Dodgson—better known as Lewis Carroll, the author of "Alice in Wonderland"—ridiculed the claims of science to a place in university curricula. Science, he says, sat weeping at the gates. Oxford admitted her and housed her royally, adorning her palace with retorts and reagents and making it a charnel-house of bones. When the students sniffed at the sulphuretted hydrogen and turned away, science said: "Give me no more youths to teach; and pay me handsomely and let me think." Making allowance for the whimsicality of the author of "Alice in Wonderland," we may acknowledge a modicum of truth in this description of the origin of scientific research at Oxford. The sister university organised its research work more deliberately; but only in recent years has scientific research received full recognition in our ancient universities.

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[1] Third Congress of the Universities of the Empire, 1926: Report of Proceedings. Edited by Alex Hill. Royal 8vo. Pp. xxviii+270. (London: G. Bell and Sons, Ltd., 1926.) 21s. net.

As to the Government, nothing less than the greatest war in history was necessary to bring about active participation in this work. The bombs from enemy airships were actually dropping on London when the organisation of the Department of Scientific and Industrial Research was in progress. The Dominions—Australia, Canada, South Africa, and New Zealand—and India followed the example of the mother country. Not yet, however, as is shown by the discussion at the Universities Congress, have all the problems of co-operation in the field of scientific research found their solutions.

Sir Thomas Holland in his opening address to the Congress gave a résumé of the scientific activities within the Empire stimulated or organised during the War. Established streams of international exchange were altered by the War. For example, the output of wolfram in south Burma, the principal source of that mineral, was before the War sent to Germany, and the tungsten extracted therefrom, an important constituent of tool-steel, was rationed to English firms. Some precious months of intensive research under the compelling impetus of war were necessary to elucidate a satisfactory process of manufacture; but that, Sir Thomas Holland said, was only "one of the many shocks which followed the winter operations of 1914–15." In the light of such an experience, the need for "official organizations for correlation and control" could scarcely be disputed. Their relations to British universities and industries are still in process of adjustment. Sir Thomas Holland was not disposed to accept Newman's dictum regarding the independence of teaching and research. The highest teaching, he said, loses its vitality if unconnected with research. Conversely, the question arises: To what extent and in what directions does research suffer if divorced from teaching? Sir Thomas did not suggest that there was any lack of co-operation between the Department of Scientific and Industrial Research and the universities, for the Department had shown a willingness to hand over problems to research workers in university laboratories and also to assist new researches proposed by university professors. But the establishment, at home and in the Dominions, of special research institutes, wholly divorced from teaching, was a new development. Certain forms of research must be conducted on a scale beyond the capacity of the ordinary university or college. Research workers always have more ideas than they can readily develop and complete in practice, and there is a greater tendency to reserve a 'claim' in a general institute, the governing body of which may not be composed of critical specialists. This danger, however, is not apparent in Great Britain so far.

Sir John Farmer addressed himself to a problem of great Imperial interest—the work of the scientific officers attached to the agricultural departments in the Colonies and of the officers of the commercial agricultural enterprises which are growing up, especially in the tropics. These officers do their work in a solitude due to physical reasons, and Sir John Farmer's appeal to the home universities to assist them by offering a welcome to the university laboratories during their visits to the mother country should meet with an enthusiastic response. For, as he said, no one has a better right to this hospitality than the man who has been coping with problems under conditions of difficulty which would astonish those who have been accustomed to the luxurious resources of some of the modern temples of science.

A good example of the importance of agricultural problems of the tropics was given by Sir Arthur Shipley. Last year we imported 60,000,000 bunches of bananas, each containing about 80 bananas, and thus the inhabitants of the British Isles consume about 100 bananas per head a year. But many of the plantations are derelict owing to the banana disease, and any one who could find a cure for the fungus which destroys the banana would make a fortune. It is to be hoped that the prognostication will be confirmed, though there are instances, *e.g.* the discoveries relating to the transmission of malaria, which would discourage over-confidence of financial reward. However, the colonial scientific research service has many attractions for the enthusiastic worker, as Sir John Farmer insists, and his appeal for "the fertilising effects of intercourse with others who are pursuing similar or analogous paths of scientific work" refers to a psychological aspect of the question of co-operation in research the importance of which it would be difficult to overstress. As a good example of co-operative research, he instanced the work of the Food Investigation Board, under the able direction of Sir William Hardy. Scientifically, the work is mainly rooted in Cambridge, with a smaller root system in London. The essence of its success was to be found, he suggested, in the completeness of the chain of co-operation.

Dr. Andrew Balfour, Director of the London School of Hygiene and Tropical Medicine, also discussed the Imperial aspects of the question, emphasising the waste of time, money, and energy, "owing to the fact that in the great and important domain of tropical medicine men are, to a large extent, working in watertight compartments." Thanks to the Colonial Office, things are improving, and he commended also the work accomplished in India by the Scientific Advisory Board.

The important part which India is destined to play in the promotion of scientific research was well brought out by several Indian speakers. As Sir Jagadis Bose said, there has never been in India any real conflict between religion and knowledge. Those who pursued knowledge regarded themselves as dedicated to a sort of religious life. "In India," he said, "we combine all these qualities—inner vision, power of invention, control of our hands." India is determined to be the brightest jewel in the Imperial crown by reason of its contribution to the spiritual wealth of the British Empire. If the spirit of co-operation in research can be developed, the Empire will become, as Prof. Radhakrishnan said, "a spiritual whole" and thus serve the interests of humanity.

T. Ll. H.

The Work of the British Geophysical Observatories.

Air Ministry: Meteorological Office. The Observatories' Year Book, 1923: comprising the Results obtained from Autographic Records and Eye Observations at Lerwick, Aberdeen, Eskdalemuir, Cahirciveen (Valencia Observatory), Richmond (Kew Observatory), and Benson. Published by Authority of the Meteorological Committee. (M.O. 279.) Pp., 371 + 12 plates. (London: H.M. Stationery Office, 1926.) 63*s.* net.

ONE of the important functions of the Meteorological Office is the maintenance and administration of the observatories at Lerwick, Aberdeen, Eskdalemuir, Valencia, Benson, and Kew, at which a considerable variety of geophysical work is done. The volume under review is the record of that work for 1923 and forms the second of a series which replaces certain sections of the well-known "British Meteorological and Magnetic Year Book." The evident purpose of the new series is the collection in compact form of all the work done at each observatory.

The six institutions named differ in their aims and, apparently, in the power of their equipment to deal with the wide range now covered by geophysical investigations. Lerwick Observatory, opened in 1921, is as yet confined to terrestrial magnetism, and even for this subject the staff and equipment have been so restricted that the enormously important work waiting to be done there cannot be undertaken. Aberdeen is concerned solely with meteorology and has earned a high reputation in the study of cloud forms. Eskdalemuir is primarily a magnetic observatory, but includes atmospheric electricity, seismology (since removed to Kew), and meteorology. Kew, after a long and honoured record of research in terrestrial magnetism, is changing in character and its present functions appear to be somewhat indefinite. Benson has been occupied with work on the upper air, but has been closed on this work being transferred to Kew. Valencia is a 'first order' meteorological station and includes in its programme a weekly observation of the magnetic elements.

Such diversity of aim is explained by the historical development of each observatory, and chiefly by the circumstance that, in their origins, they are not all creations of the Meteorological Office. From one point of view it may be regarded as an element of strength rather than of weakness. The important matters are, first, that where their aims are common their results should be comparable; and, secondly, that in each subject of inquiry or record, its distribution among the observatories should provide an adequate representation of the area with which they are supposed to deal.

With regard to the first of these, the volume now under review gives ample evidence of the care taken by the Meteorological Office to bring its records to a common measure. Take, for example, the hourly readings of atmospheric pressure at Aberdeen, Eskdalemuir, Valencia, and Kew. In all respects, except that of height above sea-level, they are entirely comparable, and the inquirer is not maddened by doubts as to the exact position of the recording instrument, the times and methods of observation, the units employed, and the corrections applied. Nor is he referred for information on such matters to some former publication to which he may not have immediate access. The same may be said of records of temperature, humidity, sunshine, and rainfall at these four stations. Although it would be absurd to become dithyrambic over the thousands of columns of figures in these tables, they recall Gibbon's praise of the learned Lutheran's encyclopædic treatise, for they are "full, rational, and correct." Closer scrutiny, it is true, will reveal minute differences in observatory practice in compiling some of the other tables, but, except in one, they are not serious. Aberdeen seems to enjoy a monopoly in atmospheric optical phenomena. Further, the occurrence of such phenomena is entered sometimes under the appropriate hour, sometimes in the "Remarks" column, and sometimes in both. Unusual visibility is frequently recorded by the Beaufort letter, occasionally by the Beaufort symbol, and may appear indifferently under the hour or in the "Remarks." The exception referred to is that of wind measurement, for there is still a distressing variety in the instrumental means employed for the purpose at the different observatories. But taking them as a whole, there can be nothing but praise for the laborious care which has been bestowed on the preparation of these fundamental tables.

The second point referred to above may be fitly exemplified by considering the arrangements for continuous registration of wind over the British area. For a comprehensive study of this subject the materials are, as yet, far from complete. In addition to the observatories there are about thirty other anemometric stations within the area. But their distribution cannot be regarded as satisfactory. About half of them are to be found along or close to the English Channel coast, and it is abundantly evident that their increase in recent years has been rather in the interests of the applications of meteorology to aviation, than in those of the pure science itself. Here, as elsewhere, it must be insisted upon that in the last analysis these latter interests must be predominant. Again, considering the importance to the study of British weather of the frequent depressions in the Icelandic region, one would expect that the north-west coast of Scotland might be represented in the distribution. But until the establishment last year of a new anemometric station on the island of Tiree, this area was a blank. Information is still required from such places as St. Kilda, North Uist, and from Lerwick Observatory, where wind blows with an intensity unknown to the Sassenach. The wind data from the observatories published in this volume are as complete as can be reasonably expected and are admirably arranged. The annual distribution of frequency might be supplemented by the figures for previous years, for these are not in all cases readily accessible. Prof. Becker has published results which would indicate a very marked decrease in the frequency of high winds over the Glasgow district during the last half-century, and it is more than a merely superficial impression which inclines one to the belief that there has been a parallel decrease in the frequency of gales in the North Sea. It would be of interest to have these conclusions examined.

It is not the object of the "Year Book" to give any discussion of general results deducible from the meteorological data. A partial exception to this general rule is to be found in the harmonic analysis of diurnal variations of atmospheric pressure at Eskdalemuir, Valencia, and Kew, and of temperature at the two latter stations. Those for Aberdeen are not given, for some reason unexplained. This extension of the tabulated data is most welcome. But it is hoped that it will not be taken as an indication of ingratitude if a request be made for still more; that is, that the hitherto unpublished series 1913–21 be similarly analysed and issued. The subject of the diurnal variation of pressure—to which the present Director of the Meteorological Office has already made a notable contribution—is by no means exhausted, but its advance in some directions is largely impeded by the lack of trustworthy data. It may also be suggested that the value of the "Year Book" would be considerably enhanced if similar records were obtainable from Lerwick Observatory, almost the only station in the northern hemisphere providing an exposure free from the influence of large land areas, which have such marked effects on the different terms of the harmonic expansion. As Sir Napier Shaw once remarked on a parallel case, it is "somewhat depressing that the world should be content to go on without the knowledge which is needed for calculations such as this, and which is within the reach of effort." It is well known that the solar part of the diurnal pressure inequality is affected by some of the various factors which make up the meteorological character of the day, and among these, principally, the occurrence of deep depressions, with the consequent uncertainty as to the distribution of non-cyclic change. For the investigation of such effects the new arrangement of the "Year Book" is especially well adapted, since nearly all the information required for any classification of days is given in the volume.

The magnetic data published in the "Year Book" are chiefly those from Eskdalemuir, and they are given with a completeness which leaves little scope for criticism. Full details of the bi-weekly absolute determinations of D, H, and I are given, together with the base-line values, both deduced and adopted, of the N, W, and V magnetographs. But here is, as yet, no indication of the use of modern electromagnetic methods for these fundamental determinations. The tabular matter includes hourly values of the three geographical components; hourly means for each month, and daily means for each day; maximum and minimum for each day, with the time of occurrence; absolute daily range, and the magnetic 'character' of each day. The diurnal inequalities are given very fully for 'all' days, quiet days, and disturbed days, and they are further expressed in terms of their harmonic components. The series of notes on the magnetograms of the year are of interest, for they provide abundant matter for speculation and study. What makes these notes of value is that there appears to be a better prospect of elucidating terrestrial magnetic disturbance by the study of the same disturbance in the records of several stations, than by lumping together all disturbances at one station. For example, there is sound reason for the full investigation of the diurnal variation on the same magnetically quiet days at all stations. But similar inquiry on highly disturbed days introduces elements of great uncertainty, chiefly dependent on the selection of days regarded as disturbed, on the hour of day at which a disturbance begins, and on the fact that disturbances are not all of one type. This is borne out by the vector diagrams shown in the "Year Books" of 1922 and 1923. For quiet days there is practical constancy in type for the respective seasons, while for disturbed days there is marked variation in type. But the more intensive study of the details of each world-wide magnetic storm involves a degree of international co-operation which is, as yet, far from realisation.

The magnetic results from the new observatory at Lerwick appear for the first time in this issue of the "Year Book." Until the instruments have settled down—there was heavy 'drift' on the *H* magnetograms—the published data are confined to diurnal inequalities of the horizontal components, daily range in declination, and to general annual results. These show that magnetic disturbance at Lerwick is on a much larger scale than at Eskdalemuir, itself a fairly disturbed station. For example, the daily range in declination at Lerwick on Sept. 27, 1923, exceeded 2¼°—very much greater than it would have been at Eskdalemuir. Dr. Chree contributes an interesting discussion of the chief results. The volume also includes a summary of the auroral log of the observatory, but this is practically confined to a list of the fifteen dates on which auroræ were visible. The powers that are swayed by the "interests of brevity," to which apologetic reference is made, have evidently been at work. Nothing is said as to any extension of the auroral work, one of the chief objects for which this observatory was established.

Eskdalemuir Observatory contributes its earthquake and microseismic records, and these are given in full. In connexion with the latter, there are interesting notes intended as comment on the theory that microseismic amplitude and the travel of cyclonic depressions over the European area are correlative. The agreement with the Strasbourg microseismic record is at times very striking. Among minor, but not the less important and interesting, subjects there may be noticed the atmospheric potential gradient measurements at Eskdalemuir and Kew; the record of atmospheric pollution at Kew; and the soundings by registering balloons sent up from Benson.

The "Year Book" is the record of an immense amount of laborious work in measurement, tabulation, and computation. Much of it, necessarily, is of the nature of that routine which tends to diminish zeal, but the work has been carried through on a level, in respect of quality, which commands nothing but praise. The Meteorological Office has many functions to fulfil. Some of these —forecasting weather, for example—are of general importance; others—among which may be classed the provision of information for aviators—are significant of administrative accident rather than of importance in themselves. But it has also the paramount obligation of providing the material for the advancement of that science upon which its own activities are based. The present substantial addition to the published data of geophysics is a welcome evidence that this responsibility is being discharged, and on its issue the Meteorological Office must be congratulated.

A. CRICHTON MITCHELL.

Geology of South Africa.

The Geology of South Africa. By Dr. Alex. L. Du Toit. Pp. xi + 463 + 39 plates. (Edinburgh and London: Oliver and Boyd, 1926.) 28*s*. net.

SOUTH Africa is characterised geologically by its unity in plan and its variety in structure and composition. It is of special interest to European geologists, as its Karroo formation is an important supplement to their records, as it claims to be the original home of reptiles, mammals, and man, and as it contains the most prolific of the world's goldfields and diamond mines, and the largest known supply of primary platinum ores.

Its present unity and isolation are due to Mesozoic movements that severed it from South America and Australia, which have many features in common; for the three areas shared the same early geological history, presenting, however, the differences that might be expected from such far-distant sections of the same continent.

The geology of South Africa is well adapted to individual treatment, and it has been described in an excellent series of text-books, of which that by Dr. Du Toit is the latest and most complete; it will be exceptionally useful from its concise statement of the evidence, its references to the literature, its beautiful map, clear plates and diagrams, and the author's sound and cautious judgment. His caution is shown in dealing with the oldest South African rocks. He is confident that they are pre-Devonian, but how far they are Palæozoic or pre-Palæozoic he leaves open. The Waterberg Sandstone he treats as early Palæozoic, though no fossils have been found in it; the reviewer in 1915, when describing its north-western extension in Angola, adopted its pre-Palæozoic age somewhat tentatively, but the later evidence and drift of opinion are in favour of that conclusion.

The view that the Waterberg Sandstone is the inland equivalent of the Devonian Table Mountain Sandstone, and that the underlying dolomites are Ordovician, has had a strong appeal to South African geologists; and it was strengthened by the claim that Orthoceras had been found in the Otavi Dolomite; but as there is no mention of that fossil, it may be assumed that the author dismisses it as a concretion. The most important formation amongst the earlier rocks is the Banket of the Transvaal goldfield. The author discusses whether its gold was alluvial or due to infiltration, and says that the criteria are indecisive (p. 69); but he adds that "the placer theory appears by far the most likely," and in his final chapter he gives a graphic summary of the geological history of the field, which follows exactly the views urged by the reviewer in 1907, including the formation of the pyrites from black iron sand, the shaping of the typical Banket pebbles by beach action, the alluvial origin of the gold, and its recrystallisation, and the existence of gold in washouts through the Banket and of pebbles of that rock in the Ventersdorp conglomerates. The facts show that the gold is earlier than the Ventersdorp igneous activity to which it is attributed by the advocates of infiltration. The main difference is that Dr. Du Toit describes the pebbles as muffin-shaped instead of bun-shaped. Dr. Du Toit rejects the view of Dr. Mellor that the Banket was formed by a sudde deltaic flood, and adopts the earlier view that i was formed by long-continued surf action on sinking shore. The Banket of Southern Rhodesia which was formerly claimed by most South Africa geologists as a crush conglomerate, the autho accepts as sedimentary.

One especially valuable section of the work i the up-to-date account of the Karroo System, an of its reptiles and correlation. It includes a admirable description of the Upper Carboniferou glacial deposits and glaciated surfaces. The autho represents the glaciation as radiating from fou centres, of which one lay to the east of the presen coast. He accepts the age as Upper Carboniferous and deplores the use in Australia of "that unfortunately misleading term Permo-Carboniferous' . . . "an illogical practice that has immensely obscured the true issue." Fortunately the Australian Permo-Carboniferous is now restricte within comparatively narrow limits. The famou Dwyka glaciation was not the first in South Africa as the author describes the evidence for that i the Transvaal Period from Griqualand and Namaqualand. The coal of the Karroo does not rest o underclay, and the roots of the fossil forest described spread over the top of the coal as if th trees had spread over an accumulation of vegetabl matter on the emergence of the land. There is valuable synopsis of the Cretaceous fossils of Sout Africa and description of the recent efflorescent rocks, calcareous, lateritic, and siliceous. Dr. D Toit has given special attention to water supply and his valuable chapter on that subject describe the interesting tidal wells at Cradock in the east-central part of Cape Colony.

The economic geology of South Africa is especially instructive. The diamonds are widely scattered, and in considering their formation the autho is not unduly influenced by the Kimberley pipe. He points out that nine-tenths of the kimberlite occurrences are barren of diamonds, and it appears that at least most of those that yield diamonds contain tourmaline in addition to the mineral species proper in an ultra-basic rock. He accepts Dr. Wagner's conclusion as to the diamonds of south-west Africa, as Kaiser's monograph on that field appeared too late for consideration of its evidence for a different explanation. The most important recent contribution of South Africa to the mineral wealth of the world is that of platinum; the author gives an account of the information available as to its distribution up to the date of the completion of his manuscript. He accepts the iew that some of the platinum is a direct segregaion in ultra-basic rock; but he recognises the ulk of the ore of commercial importance as a ietasomatic formation, while the platinum in the uartz veins is also due to some hydrothermal gency. The Transvaal has not yet had any mportant output of platinum; but the prospecting ork encourages the hope that the South African ield will materially reduce the price of that useful ietal.

J. W. Gregory.

Plants and People of South-west China.

aturbilder aus Südwest-China: Erlebnisse und Eindrücke eines osterreichischen Forschers während des Weltkrieges. Von Dr. Heinrich Handel-Mazzetti. Pp. xiv + 380 + 77 Tafeln. (Wien und Leipzig: Österreichischer Bundesverlag für Unterricht, Wissenschaft und Kunst, 1927.) 24 gold marks.

UNDER the auspices of the Academy of Sciences, Vienna, Dr. Handel-Mazzetti, the ell-known Austrian botanist, made extensive exlorations in south-west China during the years 914–1918; and this handsome volume is a popular ccount of the scientific results of these travels. The book is remarkable for the wealth and beauty f the illustrations, which are reproductions of hotographs, a considerable proportion being autohromes, that depict the scenery and vegetation n their natural colours. It is the first time that ve have had an opportunity of seeing pictures of he wild habitats of many beautiful plants that ave been recently introduced into our gardens rom China. The book makes, accordingly, a strong ppeal to horticulturists; and we hope that a ranslation into English will soon be published.

Compelled by the outbreak of the War to remain n China for nearly five years, Dr. Handel-Mazzetti xplored with great zeal one of the richest floral egions in the world. During the first three years, 1914–1916, he travelled to and fro across the high lateau of western Yunnan, and made numerous scents of the lofty peaks and ranges on the oundary adjoining Tibet. He crossed and rerossed the deep gorges of the Yangtze, Mekong, Salven, and Irrawaddy, where these four great rivers, lowing parallel in a narrow space (lat. 27°-28°), orm perhaps the wildest and most romantic cenery on the face of the globe. Overcoming ncredible difficulties with limited resources, he massed a vast collection of botanical specimens, nd took numerous photographs and observations illustrating the topography, geology, and ethnology of the region.

During 1914, Dr. Handel-Mazzetti went northward into the province of Szechwan, and penetrated into Ta Liang Shan, the secluded kingdom of the Independent or Black Lolos, an interesting aboriginal race, to whom he devotes a chapter of description and several pictures. Scattered through the book are notes and illustrations of many other peculiar peoples—Moso, Nahsi, Lissu, Miao, and various Tibetan tribes. An attractive autochrome (Pl. 36) represents the Moso village of Kua-pi, the seat of an hereditary chief.

Special attention is paid to plant ecology, all the different formations being described and illustrated. We may quote as an example Pl. 39, which represents in colour a mountain meadow at 11,000 feet altitude, gay with flowers of Primula, Pedicularis, Trollius, and Anemone. The most characteristic genus of woody plants is Rhododendron, of which more than 300 species have been distinguished in China. Twenty of these are shown in their natural surroundings.

Of herbaceous plants, Primula is perhaps the genus richest in species; and Pl. 110 shows one of the most beautiful of these, *P. calliantha*, growing at 14,000 feet elevation. Of the orchids, *Cypripedilum ebracteatum*, depicted in colour in Pl. 76, is most remarkable. Other showy flowering plants, figured in their native habitat, are the giant gentian, *G. stylophora*, shown in Pl. 50, and *Lilium giganteum*, Pl. 104, which are common in open glades of the mountain forests.

Conifers constitute the mass of the forests at high altitudes in western China, and are rich in indigenous species. Dr. Handel-Mazzetti's discovery of the rare Formosan genus, Taiwania, in the gorges of the Salwen River, is a notable achievement. He also found the so-called 'arbor-vitæ,' *Thuya orientalis*, forming woods in the valley of the Mekong. This tree, commonly planted around temples and in cemeteries throughout China, has been supposed until now to be a native of the Peking mountains; but its occurrence in the wild state in southern China suggests that it has been carried from there northwards and distributed by Buddhist priests.

In 1917, Dr. Handel-Mazzetti left Yunnan and travelled eastward across the province of Kweichou into southern Hunan, ultimately reaching Changsha, the capital of the latter province. Here he remained for some time exploring the mountains to the westward, but under great difficulties, as the Chinese were at the moment in a state of civil war.

The account of his explorations in Kweichou and Hunan, where he broke new ground, are of great interest; and the illustrations show wonderful scenery and rich vegetation. He left Changsha for Shanghai on Feb. 26, 1918, and this date marks the end of a succession of perilous journeys in the cause of science.

A. Henry.

Our Bookshelf.

Classified Problems in Chemistry. By D. B. Briggs. Pp. viii + 152. (London: Sidgwick and Jackson, Ltd., 1926.) 3*s.* 6*d.*

The author has made a praiseworthy attempt to provide a number of numerical problems in chemistry, arranged in methodical order for use in schools. Many of the examples are taken from examination papers of British universities, the Civil Service, and other authorities, quite a number being culled from Cambridge Tripos papers. The arrangement of chapters and sections is excellent, but the explanatory notes might have been expanded, since they will scarcely suffice for the solution of all the problems. Instead of four pages of notes on the use of logarithms, a section might have been included dealing with limits of error and accuracy, a stumbling-block to many beginners. The method of calculation on p. 24 is admirable, but in dealing with volumetric analysis it would have been better to explain the use of equivalent weights, the dependence of equivalents on the reaction studied, and the effect of any change in the equivalent weight of a compound. Experience has shown that many pupils on leaving school have failed to grasp the simplicity of this method of calculation, and until it is generally adopted, volumetric analysis will appear to be more difficult than it is.

A number of inaccuracies have been detected; for example, in question 10, p. 31, the molecular weight of ammonia can not be deduced from the data, nor can the atomic weight of the metal be found accurately in question 12, p. 47. The weight of potassium chlorate in question 22, p. 78, is not 1·08 grams, and the percentage of silver in question 44 on p. 134 is incorrect. Teachers will nevertheless find the book most useful.

Organic Syntheses: an Annual Publication of Satisfactory Methods for the Preparation of Organic Chemicals. Editorial Board: Henry Gilman, Editor-in-Chief, Roger Adams, H. T. Clarke, J. B. Conant, C. S. Marvel, Frank C. Whitmore. Vol. 6. Pp. vii + 120. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1926.) 7*s.* 6*d.* net.

The preceding volumes of this series have been reviewed in these columns and are well known to most chemists. The present volume is in every respect similar. Some of the syntheses described are likely to be of use to research workers in the preparation of their starting materials, such as the syntheses of acrolein, benzil, octanol, and hexanol, but others are more of the nature of student preparations. The reviewer himself has tested the synthesis of acrolein given, and found that the notes simplify the process considerably and tha the yields quoted can easily be reproduced. Th volume also contains the recent references in the current literature relating to syntheses publishe in the previous volumes, and the policy is adhere to of repeating syntheses when improved method have been afterwards described, *e.g.* benzil. Whil these volumes serve a very good purpose, it is great pity that the price charged should be so large As it would ultimately be best to have the volume bound together, it would be a good plan if a cheape edition were published with less elaborate binding

A Manual of Navaho Grammar. Arranged by F Berard Haile. Pp. xi + 324. (St. Michaels, Ar zona: Franciscan Fathers, 1926.) 6 dollars.

This study of Navaho grammar, which it may be said is a very thorough piece of work, might we be recommended not only to the student of the linguistics of the North American Indian, but also to those who are interested specifically in hu psychology. The chief grammatical devices fo the expression of ideas in Navaho are the nou and the verb. Of these the verb is of specia importance in this connexion, as it most markedl brings out the distinctive point of view of the Indian mind, which emphasises minute detail in relation to perceptible things. These are describe with infantile accuracy. The verb structure therefore gives expression to the attention which the Indian pays to size, shape, form, directional position and like qualities of the subject. A great deal o work is thus thrown on the verb by means o adverbial prefixes and suffices. In Father Haile' arrangement of the grammar, careful attention has been given to this aspect as well as to the verb stem Notwithstanding a considerable amount of researc along this line, the author acknowledges that muc still has to be done.

Exploring England: an Introduction to Nature craft. By Charles S. Bayne. Pp. 216 + 16 plates (London: Jarrolds Publishers London, Ltd n.d.) 7*s.* 6*d.* net.

The 'exploring' of this work is the exploratio of the naturalist in the familiar places of th country-side, and 'England' need scarcely hav limited the study, for with few exceptions th creatures described occur throughout the British Isles, while at least one of them, the crested tit is confined to Scotland, and others, like the dottere and the grey lag-goose, are mentioned only in connexion with their nesting there. In turn th author visits the hedgerows, the woods, the stream and marshes, the coast, and so on, and describe the plants and animals which are likely to be found in each type of area. There are many shrewd observations on the habits of wild creatures, bu the descriptions and illustrations are insufficient in many cases to guide the novice to the identity of his quarry, and that is a first essential in nature craft.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Hardness of Alloys.

IN continuation of my note on the hardness of etals in NATURE of Feb. 19, I now subjoin diagrams howing the variation of hardness which occur in ertain alloys of copper with the percentage of the lloying metal (Fig. 1).

The alloys were prepared by melting, in a quartz est-tube and in an atmosphere of hydrogen or coal as, the proper proportions of the constituent. Vhen melted these were stirred by shaking the tube, hich was then allowed to cool. This left the alloy n the form of a 'button,' from which the test-pieces ere cut. No hammering or any kind of work other han that required to file or grind them to a conical hape was used in their preparation; all the hardesses indicated in the diagrams therefore refer to ast metal.

In these diagrams the ordinates give the hardness n tons per square inch, the abscissæ being the olume percentage of the alloying metal, that is, so uch per cent. of the volume consists of the alloying etal and the rest of copper.

In every case, except that of bismuth, there is a ertain amount of hardening as the percentage of lloying metal increases to something like 30 per cent., nd in general the alloy becomes brittle near the oint of maximum hardness.

To determine the ordinates of the 'hardness' curves, ight alloys were prepared for each of the metals sed (or ten if pure metal at each end of the perentage scale is included), and though the brittle pecimens were difficult to deal with, I believe that he result gives a fair representation of the facts.

Some of the alloys, notably those containing tin nd antimony, though not hard, could not be cut with a saw, the saw refusing to bite when applied with a light pressure, and splintering the metal when the pressure was increased.

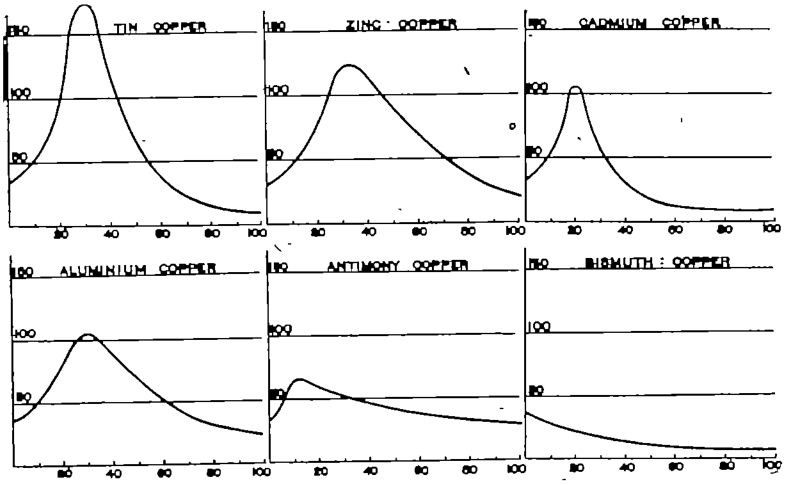

FIG. 1.—Hardness of alloys of copper. Ordinates give hardness in tons per sq. in.; abscissæ give volume percentage of alloying metal.

It seemed worth while, therefore, to measure the coefficient of friction of the alloys under such high pressures as exist at the cutting edges of the saw teeth and at the point of the conical test-pieces.

The measures were made by the apparatus sketched in Fig. 2. A platform mounted on rollers carries a polished plate of some hard material, on which the loaded test-piece presses. A lateral force is applied to the platform by a spring balance, and the reading of this balance when the force is just sufficient to cause the hard surface to slip under the point is noted.

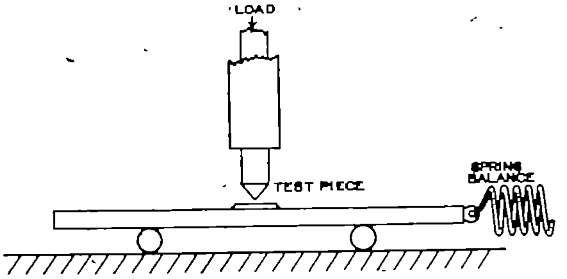

FIG. 2.

COEFFICIENTS OF FRICTION UNDER HIGH PRESSURE.

		Coefficients of Friction.	Pressure. Tons per square inch.
Steel on Glass	dry	0·12	111·0
„ „	in water	0·125	110·0
„ „	in oil	0·12	110·0
„ on Sapphire	dry	0·1	117·0
„ „	in water	0·101	117·0
„ „	in oil	0·114	117·0
Pure Copper on Sapphire	dry	0·100	20·0
Pure Cadmium on Sapphire	dry	0·1	2·3
Pure Tin on Sapphire	dry	0·124	0·22
Copper Alloy 20 % Zinc on Sapphire	dry	0·100	32·0
„ „ 28 % Tin on Sapphire	dry	0·084	68·0
„ „ 40 % Tin on Sapphire	dry	0·085	16
„ „ 40 % Tin on Steel	dry	0·090	16
„ „ 15 % Bismuth on Steel	dry	0·092	5·8
„ „ 15 % Bismuth on Sapphire	dry	0·092	3·7
„ „ 20 % Antimony on Sapphire	dry	0·094	5·2

The Table above gives samples of the result obtained. When the plates were well polished the balance readings were very consistent, and the force required to cause 'slip' was closely proportional to the load on the test-piece.

It appears that with these high pressures, lubrication has no practical effect, the lubricant, I suppose, being completely squeezed out.

It appears also that for pressures of the order employed, the pressure itself is a matter of indifference, the important factors being the nature of the materials and the product of the area of contact and the pressure, *i.e.* the load. It would occupy too much space to give the details of these experiments, which I hope to repeat with a more convenient form of apparatus.

A. MALLOCK.

9 Baring Crescent, Exeter.

The Theory of the Paramagnetism of Oxygen and Nitric Oxide.

THE two important paramagnetic gases are oxygen and nitric oxide, and to account numerically for their susceptibilities has long been a puzzle. The new quantum mechanics, together with recent spectroscopic data for nitric oxide, seem at last to solve the difficulties.

Sommerfeld ("Atombau," p. 641) has shown that the susceptibility of oxygen can be explained by assuming that, despite the presence of two nuclei, the magnetic behaviour of the O_2 molecule is like that of an *atom* in a ^3S state. This apparently involves the unreasonable hypothesis that the angular momentum responsible for the magnetic moment is directly quantised relative to the magnetic field rather than relative to the rest of the molecule. In S states the angular momentum, to be sure, arises entirely from internal spins, and spin axes are more loosely coupled than the orbits themselves. Even so, however, the internal forces doubtless ordinarily (except in highly excited states) predominate over the external field; for the latter can, in fact, be made as small as we please.

The solution of this dilemma is, I believe, found in a very general derivation I am publishing elsewhere (*Phys. Rev.*, May 1927) of the Langevin formula $N\mu^2/3kT$ for the susceptibility χ. This proof uses the new quantum mechanics and supposes only that the molecule have a 'permanent' moment μ, and that the separation between component energy levels of the normal state be small compared to kT. This condition is doubtless fulfilled in O_2, for frequencies of nuclear rotation are ordinarily small compared to kT/h, and the superposed precession of the spin axis is much slower in S than in P or D states because of the vanishing orbital angular momentum. If μ arises entirely from spin moment, then by the new mechanics we get $\mu^2 = 4s(s+1)M^2$, where M is the Bohr magneton $he/4\pi mc$ and $s = 1/2$ for doublet terms, $s = 1$ for triplets, etc., thus giving agreement with Sommerfeld's susceptibility formula for atomic S terms. There is now, however, nothing in the proof to prevent the spin axis being quantised either (*a*) relative to the axis of figure or (*b*) relative to the axis of temperature rotation (Hund's classification), or even from being coupled in a manner intermediate between (*a*) and (*b*).

The case of nitric oxide is particularly interesting. The spectroscopic data of Jenkins, Barton, and Mulliken (NATURE, 119, 118; 1927) and others, show that the normal state of nitric oxide is a ^2P doublet. The upper and lower components have respectively $\sigma = 3/2, 1/2$, and are separated by 122 cm^{-1}. Here σ is the angular momentum about the axis of figure, measured in multiples of the quantum unit $h/2\pi$, and equals $\sigma_k + \sigma_s$, where $\sigma_k = 1$ is the component of orbital angular momentum along this axis, and $\sigma_s = \pm\frac{1}{2}$ is the corresponding component for the spin angular momentum. Because the spins have twice the normal ratio of magnetic moment to angular momentum, the upper and lower components therefore have respectively magnetic moments $2M$ and 0 along the axis of figure. Calculations of the susceptibility for a mixture of molecules with two and zero Bohr magnetons, with relative abundance determined by the Boltzmann temperature factor, do not, however, agree with experiment. This failure is due to neglect of the component of spin magnetic moment perpendicular to the axis of figure. We may, on the other hand, disregard the perpendicular component of orbital moment, as this doubtless precesses very rapidly. If the precession frequency $\Delta\nu$ of the spin axis about the axis of figure were small compared to kT/h, we could simply take $\mu^2/M^2 = \sigma^2_k + 4s(s+1) =$ in the derivation of the Langevin formula cited abov Actually $\Delta\nu$ is $122c$, and so special calculations wit the new mechanics are necessary, which yield

$$\chi = \frac{4NM^2}{3kT} \cdot \frac{1+(x-1)e^{-x}}{x(1+e^{-x})}$$

where $x = h\Delta\nu/kT$. This gives a susceptibility a room temperatures corresponding to 9·12 Weis magnetons, which agrees excellently with Bauer an Piccard's experimental value 9·20. The hope o Jenkins, Barton, and Mulliken that their spectro scopic data would permit the quantitative calculatio of susceptibility is thus fulfilled. Details of th computations will be published elsewhere.

J. H. VAN VLECK.

University of Minnesota.

Influence of Carbon Monoxide and Light on Indophenol Oxidase of Yeast Cells.

WARBURG (*Biochem. Zeitschr.* 177; 1926) has shown recently that carbon monoxide at a high partia pressure inhibits the respiration of yeast and coco. cells. He also found that a respiratory substanc involved in this process has a much higher affinity for oxygen than for carbon monoxide, and that th carbon monoxide compound of this substance is dissociated by the visible rays of light.

Warburg's results as to the inhibition of respiration by carbon monoxide have been extended by Haldane (NATURE, 119, 352; 1927) to the wax-moth and cress plants.

The main object of my study was to localise the action of carbon monoxide, and to find whether the substance influenced by it has any connexion with the known respiratory substances.

Cytochrome, which is present in yeast cells, does not combine with carbon monoxide. The ordinary (unbound) hæmatin which is also present in yeast cells has, on the contrary, a much greater affinity for carbon monoxide than for oxygen, and, when reduced, it combines, even at a very low partial pressure, with carbon monoxide. Thus, none of the four different iron-porphyrin compounds of living yeast cells is responsible for the phenomenon discovered by Warburg.

In addition to hæmatin compounds, yeast cells contain a polyphenol oxidase which can be demonstrated when the reducing power of the cells is inhibited by urethane, cooling on ice, or heating yeast suspension (in phosphates at pH 7·3) to 50°-52° C., and keeping it at that temperature for an hour. 2 c.c. of a 5 per cent. suspension of baker's yeast heated to 50° C. gives a strong reaction with 0·5 c.c. of 'Nadi' mixture composed of equal parts of 0·01 M. dimethyl-para-phenylenediamine hydrochloride in 50 per cent. alcohol, 0·01 M. alphanaphthol in 50 per cent. alcohol, and 0·1 per cent. sodium carbonate in water.

The indophenol reaction of yeast is inhibited by boiling, by potassium cyanide and by carbon monoxide. The influence of carbon monoxide can be demonstrated in the following manner: 2 c.c. of the above yeast suspension is put in each of six slightly modified Thunberg's vacuum tubes and 0·5 c.c. of 'Nadi' reagent added into the bent portion of their hollow stoppers. These tubes, standing in the same rack, are filled with various gas mixtures; they are then reversed, the yeast suspension being mixed with 'Nadi' reagent, shaken for 1-5 minutes in the dark, and examined. The following are the results of such an experiment:

Tubes.	O_2 %.	CO %.	N_2 %.	Reaction.
1	7·32	63·4	29·28	XX
2	5·22	73·9	20·8	X
3	3·6	82·0	14·4	0
4	3·4	0	96·6	XXXX
5	1·8	0	98·2	XXX
6	1·1	0	99·0	XX

Similar results are obtained with yeast in which the respiration is almost completely abolished, while the oxidase is still very active.

Daylight, or the light of a ¼ watt electric lamp (50 c.p.), dissociates the carbon monoxide oxidase compound, the oxidase becoming active again. To demonstrate this, six Thunberg's tubes are prepared as in the above experiments, evacuated to about 150 mm. to 200 mm. pressure of mercury, and are filled with pure carbon monoxide. These tubes, standing in the same rack, are then reversed and their contents mixed in the dark. Of the six tubes, three are covered and kept dark, while the other three are exposed to the light by shaking the rack in front of an electric lamp. After shaking for 1·5 minutes, the three protected tubes are uncovered, and the reaction in all six tubes is compared rapidly. The result is that, while the three tubes kept in dark show only a slight blueing (X), the tubes exposed to the light show a strong blue colour of indophenol (XXXX). Control experiments with tubes filled with nitrogen instead of carbon monoxide show no difference in the rate of indophenol formation in the tubes exposed to the light or kept in the dark.

Carbon monoxide was found to inhibit in a similar manner the indophenol oxidase of mammalian muscles, and the oxidation of catechol by the aqueous extract of oatmeal flour or of dry potato oxidase preparation.

These experiments show that Warburg's respiratory ferment is a polyphenol or indophenol oxidase system, which can display its characteristic reactions even in dead cells in which the respiration is abolished. All this clearly indicates that the oxidase systems revealed by the indophenol test belong to respiratory catalysts essential for the oxygen uptake by the living yeast cell.

D. Keilin.

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University of Cambridge.

The Industrial Revolution.

I am curious to learn the grounds upon which Miss Buer (See Nature, Mar. 12, p. 379) bases her belief that the rise of population in England after 1750 was due to the introduction of the practice of inoculation and a consequent decline in infant mortality.

The accepted view is, I believe, that the rise was due in the first instance to the expansion of England's colonial trade, which increased twelve-fold, according to Edmund Burke, between 1702 and 1772. The growth of the demand for English cloth led to Kay's invention of the fly-shuttle in 1733. This invention doubled the weavers' output, raised the prices of yarn, and thus gave increased employment in the spinning trade.

Newcomen's steam-engine was introduced in 1712, and thenceforward made steady progress, resulting in an increased demand for coal. The new conditions inaugurated by the growth of trade and invention reacted upon agriculture and transport, and thus paved the way for the Industrial Revolution.

It is difficult to see how medical science could affect the size of a population. Unless there is more to divide, population cannot increase. Moreover, under the conditions prevailing in the eighteenth century a high rate of infant mortality would not affect the size of the population. Natural fertility would secure a replacement of the infant population. *Primo avulso non defuit alter.*

E. Wyndham Hulme.

Littlehampton.

I should like to reply briefly to the points raised in Mr. Wyndham Hulme's letter. In my book I have laid considerable stress on the growth of commerce and its important reaction upon agriculture and consequently upon population. My reviewer has also mentioned this, though naturally stressing other points of more immediate interest to readers of Nature.

In regard to Newcomen's engine; its use was never widespread, and, after experiment, was frequently abandoned owing to the wasteful consumption of fuel. Water-power was always preferred when available. The growth of the coal trade before 1800 was mainly due to the increasing use of coal for domestic purposes and for brewing, brick-making, forging, smelting, etc., rather than to the demands of the steam-engine. This increasing use of coal was partly due to the growing shortage of timber and partly to the development of canals.

In regard to the statement that "Unless there is more to divide, population cannot increase," from one aspect this is a truism, but Mr. Hulme seems to imply by it that production cannot be adjusted to needs. This implication is open to question. Given a sufficiently elastic social system, a growing population will stimulate production, and it undoubtedly did so in the period in question.

Neither can I agree that a high rate of infant mortality does not affect the size of a population, because the birth-rate adjusts itself to this rate. Obviously, this argument cannot hold if the birth-rate is at the maximum which natural fertility allows. The nearer the actual birth-rate is to this maximum the smaller is the possible movement of the birth-rate in an upward direction. Personally, I believe that until recent times, when the use of contraceptives introduces a new factor, the death-rate rather than the birth-rate was the prime regulator of population. In regard to the period under review, there is no evidence of any appreciable alteration of the birth-rate, but there is overwhelming evidence of a great fall in the death-rate, mainly among infants, and this fall was concomitant with a great growth of population. The fall of the death-rate was due to a variety of causes, of which inoculation was probably one. For the grounds upon which I base my conclusions I can only refer Mr. Hulme to my book, in which they are stated in some detail.

Mabel C. Buer.

The University,
Reading.

Regularity in the Spectrum of Ionised Neon.

The spectrum of neon has been completely analysed by Paschen, but certain lines were obtained by Liveing and Dewar in 1900, and afterwards confirmed by Merton (*Proc. Roy. Soc.*, vol. 89, p. 447), which are not included in Paschen's scheme. L. and E. Bloch and Dejardin (*J. de Phys.*, May 1926) obtained these lines by the method of electron bombardment, and found that the lines come out strongly at 49 volts. They ascribed the lines to ionised neon.

I have tried to classify these lines, and have succeeded in arranging about 140 of them in groups of multiplets. Taking the structure diagram of neon, namely,

$$\begin{array}{lllll} K &&&& \\ 2 &&&& \\ & L_1 & L_2 && \\ & 2 & 5 && \\ && M_1 & M_2 & M_3 \\ &&& N_1 & N_2, \end{array}$$

it is found that the expected terms and combinations are as follows:

$$\begin{tikzcd}
 & & & \begin{array}{c} {}^4L_2M_3 \\ {}^4F\ {}^4D\ {}^4P \\ {}^2F\ {}^2D\ {}^2P \end{array} \\
\begin{array}{c} {}^5L_2 \\ {}^2P \\ \ \end{array} \arrow[r] & \begin{array}{c} {}^4L_2M_1 \\ {}^4P\ {}^2D \\ {}^2P\ {}^2S \end{array} \arrow[r] & \begin{array}{c} {}^4L_2M_2 \\ {}^4D\ {}^4P\ {}^4S \\ {}^2D\ {}^2P\ {}^2S \end{array} \arrow[ur] \arrow[dr] & \\
 & & & \begin{array}{c} {}^4L_2N_1 \\ {}^4P\ {}^2D \\ {}^2P\ {}^2S \end{array}
\end{tikzcd}$$

I have obtained combinations which are combinations between ${}^4L_2M_2$ and (${}^4L_2M_3$, ${}^4L_2N_1$)-terms. Two multiplets are shown below:

	${}^4P_1$	${}^4P_2$	${}^4P_3$
${}^4P_1$	36082·3 (1)	36264·8 (3)	
${}^4P_2$	35777·6 (3)	35960·0 (2)	36182·3 (2)
${}^4P_3$		35582·9 (4)	35805·5 (4)
${}^4D_1$	32825·2 (3)	33006·0 (4)	
${}^4D_2$	32726·9 (5)	32909·5 (3)	33131·9 (3)
${}^4D_3$		32803·6 (6)	33025·7 (4)
${}^4D_4$			32944·9 (5)

A complete analysis will shortly be published.

P. K. KICHLU.

Physics Department,
University of Allahabad.
India, Mar. 3.

Herbert Spencer's Electrical Apparatus.

It may be of interest to record the fact that the electrical apparatus formerly owned by Herbert Spencer, consisting of a cylinder machine, three Leyden jars, an insulated stand and plates, with other accessories, which include an electrical pistol, is still in existence. One of the smaller pieces of apparatus bears the name G. Adams, London, who was presumably the maker, and the whole is contained in a wooden box.

The apparatus belonged originally to Herbert Spencer's father, William George Spencer, usually known as George Spencer, who kept a school in Derby and was for many years secretary of the Derby Philosophical Society founded by Erasmus Darwin. It was his practice to show electrical experiments to his pupils and at the meetings of the Society. Herbert Spencer in his autobiography says: "My father had an electrical machine and an air-pump, and from time to time classes of his pupils came to see pneumatic and electrical phenomena. I had frequently to make preparation for the experiments and aid in the performance of them. The result was that being on many occasions witness to the facts, and hearing the explanations given, I early gained some knowledge of physics. Incidentally I was led into Chemistry. One of my duties in preparing for these lectures was that of making hydrogen to fill the electrical pistol."

The history of the apparatus is well authenticated. Herbert Spencer's mother died in 1867, and shortly afterwards he gave up the Derby house and distributed most of the contents. In the autobiography he says: "Soon after my mother's death I therefore arranged to give up the house. Reserving valued relics and such few pieces of furniture as promised to be useful in London, and distributing the rest among my relations, I surrendered the key to the landlord."

It was at this time, or shortly afterwards, that Herbert Spencer gave the electrical apparatus to George Holme, who as a youth of sixteen or seventeen had saved him from drowning and had been his friend ever since. George Holme afterwards became a well-to-do manufacturer and was Mayor of Derby in 1875. An edition of Spencer's works was inscribed: "From Herbert Spencer to his old friend George Holme, without whose courageous aid rendered in boyhood neither this work nor any of the accompanying works would ever have existed." On the death of George Holme the apparatus was left to his grandson, George Hyde. At his death his widow gave it to their nephew, Mr. Colin Hyde Bennett, the present owner, whose parents still live in Derby. It is to their courtesy that the present writer owes the opportunity of inspecting the apparatus, as well as the supreme satisfaction of firing the electrical pistol, which shot its cork vigorously across the room.

FREDK. W. SHURLOCK.

6 Glenhouse Road,
Eltham, S.E.9,
April 14.

Convection of Heat in Fluid Flow through Pipes.

In his letter in NATURE of April 9, p. 527, Mr. H. F. P. Purday proposes to add yet another purely empirical formula to the many already proposed for representing the transfer of heat from a tube to a fluid passing through it. I cannot believe that much progress is possible along this line. Any further advance must, I think, be based on physical considerations, which will indicate the form of the functions involved, as to which the theory of dimensions can give us no information whatever.

It is now, I think, generally agreed, that in the turbulent flow of a fluid through a pipe there is always a layer which creeps in viscous or laminar flow along the surface of the tube, whilst the remainder of the cross-section of the tube is filled with turbulent fluid. Osborne Reynolds, many years ago, gave a rational expression for the transfer of heat from the interior surface of the viscous layer to the turbulent core. Across the viscous layer, heat transfer can only take place by conduction. If we knew its thickness we could find a complete expression for the transfer of heat from the hot wall to the fluid. Such an expression must necessarily involve at least two terms, since the transfer is effected in part by conduction and in part by convection.

Whilst it does not seem possible to calculate directly the thickness of the laminar film, it is possible from physical considerations to fix an upper limit to its maximum possible thickness. The actual thickness must be less than this, so that if the limiting thickness be found, as above indicated, the actual thickness will be ϕt, where t is the limiting thickness and ϕ a coefficient to be determined by experiment, and which has, it will be seen, a definite physical signification.

To my surprise, an examination of the experimental data indicated that ϕ was sensibly constant, the figure found being 0·55. I fully expected that ϕ would increase as the critical velocity was approached; but the experimental evidence did not bear this out.

Incidentally, I was able to show that when the fluid traversing the tube was water, which in practice always contains dissolved gases, there was a second 'critical' condition besides that corresponding to the critical velocity. Up to a temperature of about 80° C., gases are but slowly liberated from water; but if the pressure be atmospheric, they come off freely if this temperature be exceeded. This results in the breaking up of the laminar film, and there is then, as experiment shows, a sudden and large reduction in the resistance to heat transfer when the wall temperature rises above some 80° C.

The complete research was published in *Engineering* of July 6, 1923, *et seq.* H. M. Martin.

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Croydon.

The Anomalous Flocculation of Clay.

This is a rather belated reply to Prof. Comber's letter to Nature of Sept. 18, 1926 (vol. 118, p. 412), but we should like to refer to one or two points. It is a little difficult to be sure of what Prof. Comber means by the statement that "Flocculation of clay by calcium salts is anomalous when considered in the light of prevalent theories," when, perhaps, no theories on this question can be said to be prevalent. With regard to the facts (on which the theories ought to be based) we profess to have established the following:

(1) Clay flocculated by dilute hydrochloric acid and then purified from electrolytes by dialysis or other means is nearly free from exchangeable bases.

(2) Such clay (containing only 0·1 per cent. of replaceable calcium) is readily flocculated by sodium hydroxide: this seems in direct conflict with the last paragraph of Prof. Comber's letter. Further, kaolin and pure silica containing no exchangeable calcium can be readily flocculated by sodium hydroxide.

(3) It is more easily flocculated by the chlorides than by the hydroxides of either sodium or calcium where the concentration of the base does not exceed 0·5 N and 0·002 N respectively.

(4) At higher concentrations it is more easily flocculated by hydroxides than chlorides, and this is true both for sodium and for calcium.

(5) In the case of suspensions of pure silica containing only particles less than 2μ diameter, flocculation cannot be brought about by the chlorides at concentrations up to normal, whilst in the case of the hydroxides, $N/60$ and $N/10$ are sufficient for calcium and sodium respectively to produce flocculation in one hour.

(6) The flocculation of silica differs from that of clay in that the former is only flocculated by sodium or calcium chloride in an alkaline medium. The concentration required decreases with increasing alkalinity, and this also holds for clay above a pH of about 9. If, however, a small amount of aluminium hydroxide is precipitated on the silica, there results an electro-negative suspension of which the behaviour towards flocculants is remarkably similar to that of clay. In particular, it shows the phenomenon of successive flocculation, deflocculation, and flocculation on the addition of increasing quantities of alkaline solutions of sodium chlor , as described in the case of clay in our previous letter to Nature (May 1, 1926, p. 624).

These are the facts so far as we have gone: silica and clay are certainly different in respect to flocculation phenomenon, but it is better not to call either anomalous.

A. F. Joseph.
H. B. Oakley.

Wellcome Tropical Research Laboratory,
Khartoum, Mar. 15.

The Financing of Research Associations.

Many of the industrial research associations of Great Britain have, in the opinion of the leaders in their respective industries, amply justified their existence. In view of the possible cessation of their State subsidy, these associations must consider means for raising revenue adequate for their continuance on a permanent basis.

The present method of soliciting annual donations from firms and trade associations leaves a research association in a recurring state of financial uncertainty which makes it difficult to plan any extensive or expensive research. The refusal of some firms in the industry to co-operate is a further handicap.

In the case of some associations, the time is ripe for ascertaining the amount of support likely to be provided from the industry itself and from the users of its products. I include the users because it often happens that they reap much of the financial benefit arising from the work of the association, as, for example, when this work results in the improved efficiency of electrical generating or distributing plant.

In industries in which a desire exists for the continuance of their research associations after the expiry of the subsidy, it would be necessary to estimate the amount needed to place the work on a satisfactory basis, and to ensure that this amount can be secured, as a minimum, for, say, ten years. It seems reasonable to ask the firms interested to agree to a voluntary levy of a small percentage of the turnover of each of them. In some industries one pound for each thousand pounds of turnover would provide sufficient revenue, provided the scheme were widely supported. No firm need disclose the amount of its turnover except, in confidence, to a chartered accountant.

Such a scheme for placing the finance of the associations on a more permanent basis is not likely to be approved by the financial heads of firms without pressure from those concerned in the continuance of co-operative research; the purpose of this letter is to impress on those readers of Nature so concerned the advisability of considering the advantages and difficulties of such a scheme, and, if approved, of pressing it on the notice of those who would need to be influenced to subscribe.

Robt. W. Paul.

Surface Film of Aluminium.

It is generally believed that the surface of aluminium is normally covered with a thin layer of aluminium oxide or hydroxide, and that the metal possesses the property of forming this film on freshly cleaned surfaces. Bengough and Hudson (*Jour. Inst. Metals*, 21, p. 143) state, "the metal is normally covered with a layer of oxide," and Seligman and Williams (*Jour. Inst. Metals*, 23, p. 169), "It is generally assumed that aluminium exposed to air is covered by a film of oxide or hydroxide which prevents the complete oxidation of the metal. The film is invisible and, so far as the writers are aware, no direct evidence of its existence on aluminium ordinarily treated has been adduced."

Until very recently we were in agreement with Seligman and Williams regarding the absence of direct evidence. During the course of experiments made with the object of studying the properties of films produced on aluminium by the Bengough anodic process, we found it was possible to isolate the films by the following method:

The aluminium, preferably in the form of thin sheet, is cut into narrow strips, and one or more of these strips is heated in a tube in an atmosphere of dry hydrogen to a temperature of 300° C. Dry hydrogen chloride is then passed through the tube. The metallic aluminium exposed at the cut edges of the strips reacts with the hydrogen chloride to form aluminium chloride, which sublimes and deposits in the cooler parts of the tube. Ultimately all the metallic aluminium is so removed and the surface films remain, together with some of the impurities in the aluminium.

By the above method it was found possible to obtain a film from normal commercial aluminium sheet. The natural film liberated in this way was extremely delicate, tended to curl, and was small in amount, but appeared to be continuous.

H. Sutton.
J. W. W. Willstrop.

Royal Aircraft Establishment,
South Farnborough, Hants,
April 7.

Formation of Organic Acids from Sugars by *Aspergillus niger*.

Under the above title we recently showed (*J. Chem. Soc.*, 1927, 200) that when *Aspergillus niger* is grown on citric acid as sole source of carbon, the formation of acetone, malonic acid, and glyoxylic acid can be demonstrated. The production of citric acid from potassium saccharate and the mould may be detected, under careful control, by Denigès' test and by oxidation to acetone. It appears, therefore, that saccharic acid may possibly be an intermediate product in the formation of citric acid from glucose by *Aspergillus niger*, as was suggested by Franzen and Schmitt in the case of the citric acid in plants (*Berichte Deutschen Chem. Ges.*, 1925, 58, 222).

This view has now received further support from our recent observation that when *A. niger* is grown on glucose as sole source of carbon, the solution contains saccharic acid, which may be isolated as the potassium hydrogen salt. This has been identified (1) by titration with standard alkali, (2) by determination of potassium, and (3) by determination of thallium in the corresponding thallium hydrogen salt. Apart from the observation of Grüss (*Jahrbucher fur wiss. Botanik*, 1926, 66, 155, 171, 177) that saccharic acid is formed by the action of the yeasts *Anthomyces Reukaufii* and *Amphiernia rubra* on glucose, this would appear to be the only recorded instance of the production of this acid by micro-organisms.

Grüss employed a medium containing glucose and traces of peptone, asparagine, potassium tartrate, and mineral salts, and the saccharic acid was identified microscopically as the cæsium hydrogen salt.

F. Challenger.
V. Subramaniam.
T. K. Walker.

Municipal College of Technology
and the University,
Manchester.

The Supposed Law of Flame Speeds.

In Nature of Feb. 12, p. 238, Dr. W. Payman and Prof. R. V. Wheeler reply to my letter in the issue of Jan. 8. They agree that deviations from the law of speeds may be expected if one of the combustibles in a complex mixture interferes with the burning of another, but claim that the deviations are small.

The examples I gave were carbon monoxide—hydrogen—air, and carbon disulphide—ethyl ether—air mixtures, but similar effects are obtained when ether is replaced by any one of a large number of combustibles. With regard to the first example, I quote Dr. Payman (*Jour. Chem. Soc.*, 1919, 115, 1456): ". . . in the present research the maximum speed of uniform movement of flame in mixtures of carbon monoxide and air is found to be *about half* the value calculated, making use of the values determined for hydrogen—air and hydrogen—carbon monoxide—air mixtures." Such a difference between the calculated and experimental values would argue more than a *small* deviation from the law of speeds.

The same conclusion can be drawn from my own determinations of speed of flame in carbon disulphide—second combustible—air mixtures. Here the 'effective' speeds of the carbon disulphide—air mixtures, as calculated from the complex mixtures, are often less than half those directly determined. This phenomenon can scarcely be ascribed to a 'cool' flame, as it occurs even with a carbon disulphide—air mixture proportioned to give perfect combustion. An account of these experiments is being prepared for publication.

A. G. White.

45 Caledonia Road,
Saltcoats.

The Origin of the Earth's Surface Structure.

Some further explanation of certain points in our letter in Nature of April 9 on the above subject is desirable.

Our argument concerning the mode of origin of the earth's surface structure does not turn upon whether dunite or eclogite forms the deeper substratum; for these substances differ but little in radioactivity and are alike in density. The uranium and thorium content of dunite (*Phil. Mag.*, May 1924) is considerably below that of the plateau basalts, and their content of potassium is practically *nil*. Hence, whether eclogite or dunite occupies the depths, we are justified in concluding that density and radioactivity vary inversely in the earth's outer regions: the intrinsic density increasing and the radioactivity diminishing downwards. If Prof. Holmes's suggestion that the lower part of the continents is dioritic in character is correct (Nature, Oct. 23, 1926), the rule still applies. Our preference for eclogite as occupant of the depths is founded on the simplification involved, seeing that this substance is to be expected therein as a piezocrystalline form of basaltic magma; for such it undoubtedly is.

While our contention that seismic evidence is not opposed to the existence of deep-seated eclogite is true, it is also true that its presence has not as yet received the same experimental support as the presence of dunite has received. We believe the experiments of Adams and Gibson have not so far been extended to eclogite. There is much to justify the expectation that when they are so extended the results will be similar.

J. Joly.
J. H. J. Poole.

The Modern 'Zoo.'

ALMOST simultaneously there have been made announcements of two proposals of great importance in the evolution of the modern zoological garden in Britain. The Zoological Society of London has acquired an estate of 400 acres, lying under the Dunstable Downs, midway between Tring and Luton, which is to be developed on lines very different from those familiar in Regent's Park; and the Zoological Society of Scotland proposes to develop its park to the crest of Corstorphine Hill, over 47 acres which it now possesses but which have hitherto been used as a golf course.

Photo] [J. C. M'Kechnie

FIG. 1.—The Polar Bear enclosure in the Scottish Zoological Park.

In magnitude the two ventures are scarcely comparable, but both are at one in indicating that the future of zoological garden development in Great Britain lies along the lines of spaciousness and freedom, and that the old-fashioned 'zoo,' cramped in space and overstocked in kind, meeting neither the needs of the animals nor the demands of the Nature lover, is on the path to extinction.

The change marks a revolution in the attitude of the public towards captive animals during the past century. The 'zoo' fashion swept over Europe in the early half of the nineteenth century: the London Zoo in Regent's Park was founded in 1828; the Dublin garden in 1830; Clifton, Bristol, in 1835; Belle Vue, Manchester, in 1836; Amsterdam in 1838; Antwerp in 1843; and Berlin in the year following. The people, animated by a sensation-loving curiosity rather than by a love of Nature, wished to see at close quarters, but in conspicuous safety, the fiercest and the rarest of animals, and the old zoos met the demand by erecting closely packed cages and stout iron bars. The public no longer sets so high store upon the cramped animal, spending a lifetime in an endless promenade of an inadequate cage, and a growing responsibility towards the animals themselves, as well as a developing artistic perception, have led to the modern ideal of surroundings approaching as closely as possible to the natural environment, in which animals may display their graces of movement and repose in the greatest permissible freedom. It is interesting to recall that the prime movers in this beneficent revolution were not the great public zoos, but the owners of private collections.

The Zoological Society of London has been fortunate in its choice of new ground. The natural slope of the Ashridge estate, rising on one side rather abruptly from the 500 ft. contour to more than 700 ft. above sea-level (and half the entire area exceeds the latter altitude), gives scope for wide outlooks and fine panoramic effects, which will add repose and nobility to their tenants. So far as possible, the natural amenities of the site will be retained, and, in place of unsightly barriers, concealed ditches and sunk fences masked by natural scenery will separate the different groups of animals. A chalk foundation affords a medium readily excavated, so that the creation of attractive caves and shelters and dividing trenches becomes largely a matter of artistic planning and moderate expenditure.

In this handsome park the Society proposes to instal the larger and more hardy of its animals, its breeding and recuperating animals, and the majority of its duplicates. But apart from foreign imported creatures, Ashridge should become a great British sanctuary, tenanted by native birds, and exhibiting, congregated as they cannot be seen in any other part of the country, the few mammals which still exist, and those which formerly existed, in Britain. The stock in the London Zoo will benefit by reduction, and Regent's Park will become the home of a typical synopsis of the animal kingdom, and of the more delicate creatures which demand special conditions of temperature, feeding, and the like.

The proposed extension of the Scottish Zoological Park is less of an adventure in more ways than one, for since its inception in 1912 the Park has all along been developed on modern lines, and the inclusion of the remainder of its 74 acres, nearly twice the extent of the Regent's Park Zoo, is but the fulfilment of a project which the Council has had in view from the beginning. Nevertheless, it is an impressive scheme. The addition will carry the Park to the ridge of Corstorphine Hill at an altitude of 500 ft. above sea-level, and, while still retaining the southern exposure which has meant so much for the welfare of the animals, will throw open a fine northern prospect across the Firth of Forth and its islands to the hills of Fife and the Highlands of Perthshire. The ground is less amenable to artificial treatment than the chalky subsoil of Ashridge, for the rock is hard and costly to excavate; but the gain is greater than the loss, since Nature has already carved the summit into rocky ridges and hillocks, affording sites which will exhibit at their best such mountain creatures as wild sheep, goats, chamois, and the like On the lower ridges it is proposed to excavate dens and shelters for carnivores, and to give over a portion to native British mammals, while the pasture land will become ranges for native and foreign deer, bison, etc.

The sole obstacle to the development of this ground is a financial one. Last year the takings showed a modest surplus of £2000, and since the opening of the Park, all its surplus income, amounting to more than £10,000, has been spent in improvements which have added to the comfort of the animals and the attractiveness of the exhibits. To lay out and utilise the new ground, and to provide further improvements in some of the existing enclosures for animals, it is estimated that £25,000 will be required. Since such a sum cannot be obtained from the present income of the Park, the Council has issued an appeal for that amount, so that the Park may become a "National Institution, unrivalled for beauty of site and natural amenity." In furtherance of the scheme, it is announced that a mid-summer carnival and fête will be held in the Park in June. The conspicuous success already attained in the development of a modern zoological park in Edinburgh indicates that the new effort of the Zoological Society of Scotland is worthy of all support.

The Theory of Strong Electrolytes.

THE general discussion on "The Theory of Strong Electrolytes," organised by the Faraday Society at Oxford on April 22 and 23, was rendered noteworthy by the foreign guests who were able to attend and to take part in the proceedings: Bjerrum, Brönsted, and Christianssen from Copenhagen, Fajans from Munich, Hevesy from Freiburg, Hückel (a former colleague of Debye) from Göttingen, Onsager (a present colleague of Debye) from Zurich, Remy from Hamburg, and Ulich (a colleague of Walden) from Rostock, represented the European universities, whilst America was represented by Harned from the University of Pennsylvania and Scatchard from the Massachusetts Institute of Technology. The delegates enjoyed the hospitality of Exeter, Jesus, and Lincoln Colleges, and the informal discussions carried on there were not the least valuable features of the meeting.

It is now forty years since Arrhenius effected a far-reaching change in the theory of aqueous solutions by introducing the conception of electrolytic dissociation, and there can be little doubt that similar importance attaches to the recent development, by Milner, and more recently by Debye and Hückel, of theories based upon the conception of 'complete ionisation' of electrolytes. This conception, although devised in the first instance to explain the behaviour of electrolytes in solution, has received important support from the study of crystalline salts, which has shown that most of them can be pictured as aggregates of oppositely charged ions, in which individual molecules cannot be detected, as well as from the electronic theory of valency, which has provided an explanation of the inability of these ions to effect the transfer of electrons which would convert them into neutral molecules.

The chief weakness of Arrhenius's theory lay in the fact that, although the dissociation of weak electrolytes on dilution with water was in accord with the law of mass action, this law broke down completely in the case of strong electrolytes, *i.e.* of all the common salts, as well as the stronger acids and bases. Many formulæ have been devised in the hope of discovering a law of dilution which should be applied to these perfectly normal, but obstinately intractable, electrolytes; but modern theory has turned back to an old expression of Kohlrausch, $\Lambda_c = \Lambda_0 - a\sqrt{c}$, according to which the equivalent conductivity Λ_c, at concentration c, is less than that at concentration 0, by an amount $a\sqrt{c}$ which is proportional to the square root of the concentration. This law, which can be tested y plotting Λ against $\sqrt{c}$, has been verified for a rge number of salts both in aqueous and in non- ueous solutions, and appears to have a wide nge of validity; but the constancy of the index as challenged in a paper by Ferguson and Vogel, ho assert that the index varies from 0·38 in arium bromide to 0·635 in lithium perchlorate, lthough the average for thirty-three salts is only ust below 0·5. The theory of Debye and Hückel as the merit of deducing Kohlrausch's law from he fundamental laws of electrostatics, so that the ndex ½ appears as an echo of the index −2 of oulomb's law.

The theory of Debye and Huckel is based on the ostulate that each negative ion in a solution is urrounded by a region containing an excess of ositive ions, and conversely. Such a distribution quite practicable, since it is realised in the lattice f the crystalline salts; thus, in the case of odium chloride, the closest neighbours of a sodium on are 6 chloride ions, followed by 12 sodium ions t a rather greater distance, and then by 8 more hlorine ions at a slightly greater distance still. n electrolysis, this surrounding atmosphere of ions drawn through the solution, and creates an ncreased frictional resistance by dragging the olvent with it, as in the phenomenon of electrophoresis. Moreover, since the atmosphere of ppositely charged ions lags behind the ion under onsideration, as soon as it begins to move, a etarding electrostatic potential will be set up, the trength of which will depend on the rapidity with which the excess of oppositely charged ions is dissipated in the rear of the moving ion and ollected in the new region into which it is advancing. The calculation of the magnitude of hese effects presents a very difficult problem in statistical mechanics, but it can be shown in both ases that the resultant decrease of equivalent onductivity is proportional to the square root of he concentration. Kohlrausch's law can therefore be explained as due to variations of ionic nobility, resulting from the phenomenon of nterionic attraction, without requiring any variaion in the number of ions involved in carrying he current.

The formulæ of Debye and Hückel give results which are not yet in precise numerical agreement with experiment, although a closer agreement is obtained by making use of a modification due to Onsager, in which (by allowing for the Brownian movement of the ions) the numerical factor is reduced in the ratio 1 : 0·586. It is, however, a fact of fundamental importance that the theory of interionic attraction has at last provided a physical basis for Kohlrausch's law, since the earlier theory of electrolytic dissociation led to an entirely different, and incompatible, relationship between conductivity and concentration. On the other hand, it is a disappointment to find the old warning repeated, and in a still more emphatic form, that the formulæ now used are only valid in 'dilute solutions,' and that a close concordance between theory and experiment is not to be looked for in solutions of greater concentration than $N/100$ or $N/1000$, since it was at least reasonable to hope that the new theory of strong electrolytes would be applicable to strong solutions also.

An important question was raised at the discussion as to whether the theory of strong electrolytes requires that *all* the ions must be free, even in solutions of high concentration. The momentary existence of pairs of ions which have insufficient kinetic energy to separate from one another appears to present no difficulty, and may perhaps be covered by the existing equations. Numerical calculations suggest that the number of these neutral doublets is small; but as the new formulæ are only valid for solutions of extreme dilution, no experimental verification of these calculations is possible On the other hand, Walden's observations of the small conductivity of salts such as $[NEt_4]^+I^-$, when dissolved in solvents of low dielectric capacity, indicate that the proportion of electrically neutral doublets may under some conditions be quite as high as that of the undissociated molecules of Arrhenius's theory. The same conclusion can be deduced in a still more emphatic form from the fact that potassium bromide behaves as an insulator when dissolved in liquid bromine, although phosphorus pentabromide acts as an electrolyte in this solvent.

During the discussion the position was generally adopted of classifying as 'weak electrolytes' all those compounds in which real molecules can be formed from the ions. This classification can scarcely be valid, since hydrochloric acid has all the properties of a 'strong electrolyte,' in spite of the fact that anhydrous hydrogen chloride has just as much claim as hydrogen cyanide to be regarded as a covalent compound. These neutral molecules are, however, so readily ionised by contact with water that it is only in concentrated solutions that they become sufficiently numerous to produce a marked vapour pressure. Since the theory of Debye and Hückel only applies to dilute solutions, it may be taken for granted that no difference would be detected by means of it between a strong electrolyte which is wholly ionised even in the solid state, and one in which the real molecules of the crystal are resolved almost completely into ions by the influence of an ionising solvent; in a hydrocarbon solvent, on the other hand, both types of solute would behave as weak electrolytes.

The problem of solvation was also discussed. Mr. R. H. Fowler expressed the view that, since water behaves as a dipole, it must be attracted towards the ions, and expecially to those of small radius. A pressure gradient would thus be set up which would check the approach of all other ions, whether of similar or of opposite sign. The orientation of the water molecules would be reversed with the sign of the ions, as suggested by Ciamician in 1891, and formulæ expressing this view were included in a paper by Ulich.

The applicability of Stokes's law to ions was repeatedly challenged, as also was Walden's relation between mobility and viscosity; but it seems likely that these relations will continue to be used in future arguments in reference to the mechanism of conductivity, if only as providing a standard from which deviations can be measured. On the other hand, it is equally clear that all such arguments will henceforth be dominated by the theory of interionic attraction, in one form or another. The Faraday Society is therefore to b congratulated on having secured so lively a di cussion of the subject. This discussion, with th twenty-seven papers circulated before the meet ing, will provide the basis for a most valuabl report.

T. M. L.

Obituary.

Dr. Abraham Levin.

The tragic death of Dr. Abraham Levin on April 20, within a few minutes of leaving his laboratory at Plymouth, deprives physiology of a young and brilliant worker. A man of versatile talents, he showed from an early age a remarkable mechanical ingenuity and an extraordinary aptitude for engineering. This subject he studied in Rome, but long-continued ill-health, exaggerated in later years by privation during the Russian revolution, prevented him pursuing this study further. He therefore turned to other less exacting activities and studied music at Kieff with great success.

At the outbreak of War, Levin took up the study of medicine at the Crimean University at Simferopol, where he took his M.D. Prof. Gurvitch recognised his ability and made him his assistant. His mechanical bent resulted in the invention of a highly ingenious sphygmometer. Being able to come to England in 1924, his tireless mental energy found an ideal outlet in research with Prof. A. V. Hill at University College, London, and at the Marine Biological Laboratory, Plymouth. Levin's mechanical ability here stood him in the greatest service and enabled him to perform many beautiful experiments on the viscosity and elasticity of muscle and on the action current in nerves, as his published work shows.

Unfortunately, much of Levin's work is not yet finished; he died in the middle of a series of experiments on the action current in Crustacean nerve, which promised to yield results of the highest importance to the theory of nervous conduction and excitation. He was a man of the highest promise in his field of research, and his early death is a very great loss.

C. F. A. P.

The issue of the *Physikalische Zeitschrift* for Feb. 15 devotes twelve pages to the obituary address delivered in the hall of the Physikalisch-Technische Reichsanstalt at Charlottenburg on Dec. 18 by Dr. F. Henning, following on the death on Sept. 19 of his friend and colleague Dr. C. F. L. Holborn, head of the Heat Section of the Reichsanstalt. Dr. Holborn was born at Göttingen on Sept. 29, 1860, and after attending the local Realschule entered the University in 1879, and passed the government examination for teachers in 1884. He elected not to teach, but entered the Observatory as assistant to Schering in the terrestrial magnetism department, and in 1887 took his doctor's degree with a dissertation on the daily variation of the magnetic elements. In 1890 he joined the Reichsanstalt as assistant and rose gradually to be head of the Heat Section. For a time in 1924 he acted as director of th establishment, and the date of his retiremen from office was put three years later than th usual age of sixty-five years. His work on th temperature scale and on the thermal propertie of gases has proved of great value for both scienc and industry.

We regret to record the death of Sir Phili James Hamilton-Grierson, who died suddenly o Monday, April 25, at Kemnay, Aberdeenshire, a the age of sixty-six years. He was educated a Cheltenham College and Merton College, Oxford taking his degree in 1876. A member of th Scottish Bar, he held a number of legal appointments in Scotland, was knighted in 1910 an received the honorary degree of LL.D. from th University of Edinburgh in 1920. In addition t editing a number of legal works, he was the autho of several articles which appeared in Hasting "Encyclopædia of Religion and Ethics," but hi most important contribution to scientific literatur was "The Silent Trade: A Contribution to th Early History of Human Intercourse," a valuabl book in which he brought his legal training t bear upon the facts and underlying principle involved in primitive systems of economics an exchange.

We regret to announce the following deaths:

Dr. A. W. Brightmore, engineering inspector at the Ministry of Health and formerly professor of structural engineering at the Royal Indian Engineering College, Cooper's Hill, on April 20, aged sixty-two years.

Dr. W. Collingridge, formerly Medical Officer to the Port of London and the City of London, on April 29, aged seventy-three years.

Prof. W. H. Dall, palæontologist of the U.S. Geological Survey since 1885 and honorary curator of the Division of Mollusks of the U.S. National Museum since 1869, on Mar. 27, aged eighty-one years.

Mr. E. T. Dumble, consulting geologist in Texas and formerly State geologist, who contributed notably to our knowledge of the economic geology of the Pacific slope, on Jan. 27, aged seventy-four years.

Dr. Charles E. Marshall, director of the graduate school and professor of microbiology at the Massachusetts Agricultural College, on Mar. 20, aged sixty years.

Prof. C. C. Nutting, professor of zoology in the State University of Iowa, and vice-president in 1902 of Section F of the American Association for the Advancement of Science, who was known for his work in marine systematic zoology, and particularly on the Cœlenterata, on Jan. 23, aged sixty-eight years.

Prof. E. H. Starling, F.R.S., Foulerton research professor of the Royal Society and formerly Jodrell professor of physiology in the University of London, on May 2.

News and Views.

A STRONG commission, commencing under the chairmanship of the late Lord Milner, and comprising among others Sir Arthur Shipley, Sir Daniel Hall, Sir John Farmer, Dr. A. W. Hill, and Mr. F. B. Smith, has lately reported ("Agricultural Research and Administration in the Non-self-governing Dependencies." Report of Commission, Cmd. 2825, London, H.M.S.O., 1927. 2*s.*) on the question of the difficulty experienced in recruiting officers of satisfactory ability for research and administrative work in the non-self-governing colonies of the British Empire. The difficulty is largely put down to lack of general interest in the development of these colonies, though they form a sixth of the area of the Empire, and have 50 million inhabitants. An interim report has already been issued, upon which action has been taken by establishing a number of scholarships, similar to those provided by the Empire Cotton Growing Corporation, whose incumbents, after taking a degree similar to the Cambridge Science Tripos, Part II., shall spend one year in special training in Great Britain and one year in the Imperial College of Tropical Agriculture in Trinidad. In this way it is hoped to form a kind of reservoir from which the colonies may draw trained men, who will have had at any rate one year of tropical experience under proper guidance.

THE second part of the report before us deals with the collection and dissemination of information about the research and other work that is in progress in the different colonies, and it is recommended that a kind of central clearing-house, upon the lines of the Imperial Bureaux of Entomology and Mycology, be established in London for the purpose of collecting, abstracting, and compiling and issuing a periodical summary of information. The third part then goes on to deal with the organisation of research, and it is recommended by a majority of the Commission that a central advisory council be established in England, the chairman of which (a distinguished man of science) and secretariat shall be full-time officers, the former also travelling into the various colonies to see at first hand what is being done and to advise upon the spot. The duty of the council would be to collect information as to the work going on in every dependency, and to advise and criticise. The whole report is worth careful perusal.

DR. R. H. PICKARD has been appointed Director of the British Cotton Industry Research Association in succession to the late Dr. A. W. Crossley, who resigned the post shortly before his death on Mar. 5 last. During the past seven years Dr. Pickard has been Principal of Battersea Polytechnic, and to the responsible duties of this post he has added those of the directorship of the British Leather Manufacturers' Research Association. From 1899 until 1907, Dr. Pickard was head of the Chemistry Department of Blackburn Municipal Technical School, and afterwards principal of the same Institution until his appointment to Battersea. During this period Dr. Pickard, in collaboration with his staff, published numerous papers in the *Journal of the Chemical Society*; for the most part these deal with the preparation of the isomeric borneols and menthols in a state of optical purity, and also with the synthesis and extended examination of a very large number of optically active organic compounds of simple chemical constitution. Considered as a whole, this work forms one of the most important and systematic attempts which have been made towards the solution of the complicated and difficult problem of the relationship between chemical constitution and optical activity. This record as a scientific investigator, combined with the experience gained during the tenure of administrative posts of considerable responsibility, affords ample assurance that the various activities of the British Cotton Industry Research Association will continue to be maintained at a high level in the hands of the new Director.

DR. E. V. APPLETON'S discourse delivered at the Royal Institution on Friday, April 29, was entitled "Wireless Transmission and the Upper Atmosphere." It is now becoming more and more evident, he said, that the atmosphere has a profound influence on the transmission of radio waves through it and thus on radio telegraphy generally. The earliest indication of atmospheric influence was Marconi's successful transmission across the Atlantic in December 1901. The distances previously accomplished by Marconi were so short as to be explicable on the simple hypothesis that the radio waves travelled in straight lines. But communication to America, as the late Lord Rayleigh was the first to realise, raised a new question. Could the waves bend round the protuberance of the earth, as sound waves bend round a corner? Lord Rayleigh and others investigated the problem mathematically, and their results showed that some influence other than ordinary diffractive bending was at work. We now know that this other influence is the so-called Heaviside layer of electricity in the upper atmosphere, which guides long radio waves round the earth's curvature. All recent work has tended to prove the Heaviside layer theory, and within the last two years it has been shown that the signal fading, with which many broadcast listeners are familiar, is also due to the action of this layer. This signal fading is most marked at a distance of 100 to 150 miles from the transmitting station and is due to the interfering action of the waves sent back to the ground by the Heaviside layer.

EXPERIMENTS made in conjunction with the B.B.C. engineers and the National Physical Laboratory show that the height of the Heaviside layer is about 70 km., rising to 120 km. during the night and falling to its lower value with the advent of sunrise. The layer is only found to reflect broadcast waves copiously at night, there being practically no reflection during the day-time, when the ground waves only are received. Experiments on the very short wave-lengths have shown that the ground waves die out very rapidly with increasing distance, so that reception at great distance is accomplished only by means of waves deflected by the upper atmosphere. But with decreasing wave-length the amount of bending the atmosphere can accomplish becomes less and less, so that with very short waves a penetration of the Heaviside layer becomes feasible, especially at night when the amount of electricity in the upper atmosphere is least. Waves of the order of one metre in wave-length would penetrate it and thus be of no use for long-distance communication on the earth. A surprising result has recently been found in the effects of magnetic storms on radio transmission. Such storms interfere very seriously with long-distance short wave transmission, and yet with very long waves the signals are stronger than usual. It is possible to explain these results in terms of the Heaviside theory if we assume that a magnetic storm increases the electricity in the layer. In such a case the short waves which have to penetrate the layer to be bent gradually back to the ground are more strongly absorbed, because they are returned at lower levels where the friction experienced by the electricity is larger. On the other hand, the long waves are truly reflected by the layer at its surface, and an increase in the amount of electricity in the layer increases the amount of this reflection.

AN exhibition of modern British architecture was opened by Viscount Peel at the Royal Institute of British Architects' galleries on April 26. Organised by the Institute, this constitutes a new event to be repeated annually. It may be asked why, with the architectural room just opened at the Royal Academy, such a new departure is necessary. The explanation is twofold—the limited space at the Academy and the decision of the promoters of this new exhibition to admit photographs. Lord Peel in his speech referred to the Swedish and American exhibition of architecture previously held by the Royal Institute, and to the value of arousing the dormant artistic tastes possessed by a large section of the public by the display of good examples of current work; he also referred to the danger of producing rural slums by the indiscriminate erection of small houses without adequate artistic advice. The exhibits consist mainly of photographs, though there are a number of important buildings represented as perspectives in colour. Most of the works present domestic architecture, and it is noticeable that the grandiose buildings of the past have given way to smaller and simpler types of houses. Public buildings are also well represented, and there are examples of schools and other institutions; but visitors expecting to see interiors showing the application of the architect's work to the technical problems required to meet the needs of the man of science will be disappointed. Such a display is, however, apparently outside the scope of the exhibition. The galleries will remain open until June 3.

IN a lecture given under the auspices of the British West India Committee on April 28, Mr. Ormsby-Gore, Under-Secretary of State for the Colonies, described the work of the Empire Marketing Board. Its tasks, he said, are to bring home to every section of the community the idea and the significance of the British Empire and its resources, and to mobilise the forces of research, both economic and scientific, to assist in the better production, distribution, storage, and marketing of Empire products. To ensure the greatest possible co-ordination of research work and to guard against unnecessary overlapping, a small Research Committee has been formed. Applications for grants for scientific research are either received through the appropriate Government department or referred by the Committee to the appropriate department for consideration and advice. Grants are in general limited to researches which are likely to be of importance to the Empire as a whole and not merely of local importance; for example, research in animal nutrition and in entomology. The latter field of research is of the utmost importance, as it is estimated that one-tenth of the world's crops are destroyed by insect pests yearly. The Board is sufficiently impressed with the results already achieved in connexion with the biological control of insect pests to make a grant of £15,000 a year for five years for the establishment and maintenance in England of a sort of 'parasite zoo,' where parasites destructive of insect pests can be bred and distributed wherever needed throughout the Empire. By such work as this it is hoped that the Board will earn the support of all political parties in Great Britain and also that of the various Governments of the Empire.

THE spring floods of the Mississippi have attained unusual proportion this year. They are due to the melting of snow in the northern part of the vast drainage area of the river in March, combined with the spring rains of April. A recent article in the *Times* points out how these floods periodically attain dangerous proportions, threatening all the lower flood plains and delta of the river, which are protected from normal inundation by levees or embankments, partly of natural growth and partly of artificial construction. The last severe floods on a large scale were in 1912, and some twenty-two years earlier the floods were so heavy that the levees protecting New Orleans were breached and parts of the city inundated. This year the floods of the two rivers Arkansas and Yazoo, dammed back by the main torrent of the Mississippi, have already flooded great areas. But the most serious danger lies in the rise of water in the delta where New Orleans lies, protected by levees, ten to fifteen feet below the normal river level. In order to drain away the waters before they inundate the city, a breach has been made in the levee at Poydras, fifteen miles below New Orleans. Many miles of swamp and copse, chiefly the resort of trappers, have thus been flooded, but this measure may save New Orleans.

SIR ROBERT HADFIELD has generously provided a sum of about £200 towards the expenses of a member of the Institution of Mining and Metallurgy who would be of special service at the forthcoming Empire Mining and Metallurgical Congress in Canada, but would not be able to attend without financial assistance. A committee was appointed by the Council of the Institution to allocate the grant, and has recommended that it be offered to Assist.-Prof. Bernard W. Holman of the Mining Department of the Imperial College of Science and Technology, South Kensington. Prof. Holman had a distinguished career as a student at the Royal School of Mines, he has made noteworthy contributions to the publications of the Institution of Mining and Metallurgy, and he is a good speaker in discussions. He spent 1925–26 in South Africa, where he made a good impression in the mining fields, and it is thought that his presence at the Canadian meeting will be useful in discussing the proposed programme for the third congress, to be held in South Africa, apart altogether from his value in discussing the purely technical papers which will be read.

THE Easter Conference of the Society for Experimental Biology was held in Cambridge on April 19 and 20 in the Physiological and Zoological Laboratories, by kind invitation of Profs. J. Barcroft and J. Stanley Gardiner. A number of very interesting papers were read during the three sessions of the Society. Dr. E. Delf gave an account of her recent work, showing the beneficial effect of small doses of ultra-violet light on plants. Dr. A. S. Parkes discussed the relation of oestrin to corpus luteum. Dr. G. V. Anrep explained the present position of our knowledge of cortical activities as elucidated by the study of conditioned reflexes. Mr. J. T. Saunders showed a beautiful series of experiments illustrating chemotaxis in ciliata to *pH*. Dr. E. D. Adrian gave an account of his recent work on the nature of the nervous impulse in sensory nerves. Mr. J. Gray gave a critical account of the rôle of gravity in cell-division. Prof. J. S. Huxley described the induction of premature metamorphosis in Echinus larvæ following chemical inhibition of the larval tissues. An important feature of the conference was a symposium on the relation of evolution to heredity and environment, conducted by Mr. G. C. Robson, Mr. J. B. S. Haldane, Mr. C. E. Diver, and Dr. F. A. E. Crew. The complete adequacy of natural selection acting on Mendelian variation was pointed out, particularly in the case of small variations, and the importance of the environment both in originating mutation and in selecting the variants was demonstrated.

A JOINT meeting of the vice-presidents and members of the Councils of the Institution of Fuel Technology and the Institution of Fuel Economy Engineers was held under the chairmanship of Sir Alfred Mond on Friday, April 29. As president of both Institutions, in November last, Sir Alfred Mond, having found a general desire amongst those interested in problems of fuel economy that the two existing Institutions should be merged into one, suggested terms of fusion. Under the terms of fusion finally accepted, the name of the merged Institutions will be "The Institute of Fuel"; and the present honorary secretaries of the parent Institutions will be joint honorary secretaries of the new Institute. At the meeting the final steps for the fusion of the existing Institutions and the inauguration of the Institute of Fuel were taken. Sir Alfred Mond expressed his great gratification that the fusion had been successfully accomplished. He said that the essential importance of the problems connected with fuel economy and fuel technology to the future of British industry is becoming increasingly recognised. The Government is vitally interested in the subject, and has appointed a National Fuel and Power Committee to investigate and consult upon the various problems in their many aspects. That Committee is progressing satisfactorily with its work, and it is of the utmost importance that there should be a unified Institution, important in numbers and personnel, to investigate, advise, and instruct the committee and the community on these highly technical matters. Mr. H. L. Pirie and Mr. Edgar C. Evans were afterwards appointed joint honorary secretaries of the Institute of Fuel.

THE first conversazione this year of the Royal Society will be held on Wednesday, May 11, at 8.30 P.M.

THE King has been pleased to nominate Dr. H. H. Dale, head of the Department of Biochemistry and Pharmacology, Medical Research Council, to be, for five years, a member of the General Council of Medical Education and Registration in the United Kingdom, in succession to Sir Nestor Tirard.

PROF. RICHARD WILLSTÄTTER will deliver the Faraday lecture of the Chemical Society on May 18, at 5.30 P.M., taking as his subject "Problems and Methods of Enzyme Research." The lecture will be delivered in the theatre of the Royal Institution, 21 Albemarle Street, London, W.1.

DR. R. J. TILLYARD, Chief of the Biological Department, Cawthron Institute, Nelson, New Zealand, has been elected an honorary member of the Entomological Society of Belgium. There are only six of these honorary members, and Prof. E. B. Poulton, Hope professor of zoology in the University of Oxford, is the only other British scientific worker among them.

AT the annual meeting of the Members of the Royal Institution, held on May 2, the following officers for the ensuing year were elected: *President*: The Duke of Northumberland; *Treasurer*: Sir Arthur Keith; *Secretary*: Sir Robert Robertson.

A PUBLICATION grant of £2500 is receivable by the Royal Society from H.M. Government during the current year. The grant is available for assisting the publications of other scientific societies, as well as for assisting the separate publication of books, memoirs, etc., of a scientific nature. Applications for grants will be adjudged by the Council of the Royal Society at its meeting early in July, but should be received before the council meeting of June 10. Applications from societies will be received by the secretaries of the Royal Society; those from individuals must be brought forward by members of Council.

THE Rockefeller Medical Fellowships for the academic year 1927–1928 will shortly be awarded by the Medical Research Council, and applications should be lodged with the Council not later than June 1. These Fellowships are provided from a fund with which the Medical Research Council has been entrusted by the Rockefeller Foundation. Fellowships are awarded by the Council, in accordance with the desire of the Foundation, to graduates who have had some training in research work in the primary sciences of medicine or in clinical medicine or surgery and are likely to profit by a period of work at a university or other chosen centre in the United States before taking up positions for higher teaching or research in Great Britain. A Fellowship will have the value of not less than £350 a year for a single Fellow, and travelling expenses and some other allowances will be made in addition. Full particulars can be obtained from the Secretary, Medical Research Council, 15 York Buildings, Adelphi, London, W.C.2.

The Physiological Society was founded in 1876, and its fiftieth Anniversary was in 1926. Owing to certain difficulties the celebration of the jubilee was deferred until this year. On Friday, May 13, the Society is holding its jubilee dinner. This will be followed by an ordinary meeting at Cambridge on Saturday afternoon, and on Sunday, May 15, Prof. and Mrs. Barcroft are giving a garden party in the Fellows' Garden of King's College.

Physics generally will benefit considerably under the will of the late Prof. A. W. Scott, Phillips professor of science at St. David's College, Lampeter, who died on Mar. 7 at the age of eighty-one years. The University of Cambridge is to receive £7000 and the Royal Society £1000, the income from which is to be applied for the promotion of the physical sciences, and the British Association, the Physical Society, and the Institute of Physics are to receive £250 each. The residue of the estate, after sundry bequests, is to be divided into three equal portions, two of which are to go to the Universities of Oxford and Cambridge respectively, in each case "for the furtherance of physical science."

Applications are invited for the following appointments, on or before the dates mentioned:—An assistant lecturer in chemistry at the Cardiff Technical College—The Principal, Technical College, Cardiff (May 14). A resident director of the National Gallery of Ireland—The Registrar, National Gallery, Dublin (May 19). A senior lecturer in education in the University of Manchester—The Registrar, The University, Manchester (May 19). A lecturer on pharmacology and therapeutics at St. Bartholomew's Hospital Medical College—The Dean, St. Bartholomew's Medical College, St. Bartholomew's Hospital, E.C.1 (May 20). Two research workers at the Low Temperature Research Station, Cambridge, for researches into the principles of canning foods of animal and vegetable origin—The Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1 (May 21). A veterinary inspector under the Hertfordshire County Council and the Hereford City Council—The Clerk of the County Council, Shirehall, Hereford (May 21). A lecturer in chemistry in the University of the Witwatersrand, Johannesburg—The Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2 (June 1). A lecturer in biology and botany at the Birmingham Central Technical College—The Principal, Central Technical College, Suffolk Street, Birmingham. An assistant bacteriologist at the Wellcome Tropical Research Laboratories, Khartoum, and a laboratory assistant under the Sudan Government—The Controller, Sudan Government London Office, Wellington House, Buckingham Gate, S.W.1. A laboratory mechanic in the engineering laboratories of the Northampton Polytechnic Institute—The Principal, Northampton Polytechnic Institute, St. John Street, E.C.1. An analytical chemist—Crosse and Blackwell, Ltd., Soho Square, W.1.

Our Astronomical Column.

The Coming Solar Eclipse.—It is evident that a keen and widespread interest prevails concerning this phenomenon, so rare in England. Many pamphlets on the subject are appearing. We have received one that is published by the Burnley Grammar School. Burnley lies within the totality zone but near its southern edge. The pamphlet was largely drawn up by members of the sixth form and gives in simple terms the conditions for eclipses in general and this one in particular. There is a warning that observers in Yorkshire should not select stations with high ground to the east of them, as morning mist is prevalent in such places. A large-scale map of the district (3 miles to 1 inch) includes Caton, Giggleswick, Settle, Stonyhurst, Colne, and shows the loci of different durations of totality, and of mid-eclipse at times 5 seconds apart.

Among the hints to photographers is the suggestion that attempts should be made to obtain colour photographs of the corona and prominences; this suggestion is also made by Mr. F. J. Hargreaves (*B.A.A. Journal* for March), who gives useful notes on the different screen plates and their ratios of exposure. Two small errata in the Burnley pamphlet may be noted: p. 13, for Sivar read Sivan; p. 15, the Norway eclipse was in 1851, not 1857.

Dr. Comrie has revised the eclipse calculations, using the latest available positions of the sun and moon. He finds that the track is likely to be 1 mile north of the Almanac position and the time 5 seconds later: the alteration is chiefly due to the deviation of the sun from Newcomb's Tables. With regard to some alarmist paragraphs on the subject in the daily press, it should be noted that uncertainties of similar amount are inseparable from all eclipse predictions, and that the only people appreciably affected are those very near the southern limit of totality, who should if possible move a little farther north.

The Astronomer Royal has announced that radio time signals will be sent out at 6^h, $6^h\ 15^m$, and $6^h\ 30^m$ (summer time) on the eclipse morning. These will be the usual 6 dots, the last of which is the exac minute.

All observers can do useful work by noting the exact time of the beginning and end of totality correcting their watches by the radio signals, and indicating their exact locality, which may be done on a tracing from the 1-inch Ordnance map (or a large scale). Merely saying "in Settle" or "in Burnley" is not near enough for this purpose.

Research Items.

The Khallam.—Miss Erna Gunther has made a careful study of the Khallam, embodying existing literature, which is not extensive, in addition to her own personal observations. This has now appeared as No. 5, vol. 6, of the *Publications in Anthropology of the University of Washington*. The information obtained in the field was mainly collected at Jamestown, Washington Harbour, and Esquimault, but the Khallam formerly lived on the southern shore of the Strait of Juan de Fuca from the mouth of the Hoko River to Port Discovery Bay opposite Vancouver Island. They thus live in the region designated by Wissler as "the Salmon area," which extends along the Pacific Coast from Alaska to San Francisco bay. Their villages were for the most part on the coast, and their principal means of subsistence was sea food, especially salmon. Characteristically, agriculture was non-existent, vegetable food being obtained by gathering wild products—berries and roots. Each village, however, as a rule had one or two hunters, depending entirely on bow and arrow, who alone knew the mountainous country behind the shore. The villages consisted of a single row of rectangular houses with doors facing the water. The smaller houses were twenty feet by thirty feet; the potlatch house was fifty feet by two hundred feet. In camping, mats were carried to form temporary shelters. Their marriage regulations differed according to the social standing of the individual. People of high rank married outside the tribe; but such a marriage was only possible to families of considerable wealth; and although marriage with a relative was avoided, union with a cousin might be necessary in order not to mate with a person of lower rank. Poor people who could not marry outside the village or tribe because of the expense of the feasts involved made the best arrangements they could, avoiding parallel and cross-cousin marriages. Marriages with the northern tribes were the most desired. Most of the people are now Shakers, and it is difficult to obtain any complete account of the old religion, but, as in most of the American tribes, the secret society and the guardian spirit were prominent, while there was little idea of superior deities whom every one worshipped.

The Disposal of the Dead at Wakching, Assam.—Mr. J. H. Hutton has obtained details with photographs of a remarkable method of disposing of the dead at Wakching, a village of the Konyak tribe in the Naga Hills, which are published in *Man* for April. After death, the body is wrapped in leaves of the thatching palm and placed in one of a number of trees, usually six, associated with and usually near the *morungs* of the clan using them. Outside the village a rail is put up, with a screen, in front of which is a wooden figure of a man serving as the temporary habitation of the soul. This figure, which ends just below the waist, can be and is used for other dead afterwards. After nine days the head is detached from the body and cleaned by the children or relatives and placed in the village cemetery in a special stone receptacle. This is a solid conical sandstone block from two to three feet in height, with an arched recess to take the skull. The recess is closed with a flat stone and the whole covered with a conical sheath of thatching palm leaf. The skulls of males and females are treated in the same way, but the receptacle for females differs in shape. The fact that persons desirous of having children perform ceremonies over the stones confirms the view that they have a phallic significance. Many of the stones are ornamented with various carved patterns. Persons who die a violent death, or from an epidemic, and children, are not treated in this way. The custom of disposing of the skulls of the dead in phalli of carved stone is apparently limited to Wakching and the neighbouring hostile village of Wanching. It forms a definite link between the menhir and the carved wooden soul figure and with related customs, another link between Assam and the Pacific.

Hybrid Vigour in Grass.—The results of cross- and self-fertilisation in the grass *Lolium perenne* are reported in a paper by Mr. T. J. Jenkin (*Jour. of Genetics*, vol. 17, No. 1) from the Welsh Plant Breeding Station at Aberystwyth, where much work with grasses for pasturage is being done. Some plants were found to be highly self-sterile, and cross-pollination resulted in some cases in an increase in productivity of more than 200 per cent. It appears, therefore, that seed should be used from crosses which give the greatest F_1 hybrid vigour. Two methods of cutting were also compared, in one of which the early cuttings were omitted. The latter method gave higher yields in every case, but in some F_1 families the difference was much greater than in others. Hence it would probably be possible to select certain plants which are more suitable for grazing purposes and others which are better for hay production.

Inheritance of Rubber Yield.—The relationship of latex yield to various other features of the rubber tree, *Hevea brasiliensis*, has been studied statistically by Mr. R. A. Taylor (Bull. No. 77, Dept. of Agriculture, Ceylon). A plot of 161 trees was studied, all the trees being the progeny of a single tree at Peradeniya which is believed to be one of those sent out as a seedling from Kew in 1876. This tree had a very heavy yield, producing nearly 400 lb. of dry rubber in four years nine months. The pollen parent of these 161 trees was not controlled, but the coefficient of variation in their yield is much lower than in trees of mixed parentage. Correlation tables show a high correlation between yield in successive years. Frequency polygons show that a large number of the trees yield the mean amount or a little less, while very few show the high yields. The yield does not depend entirely on the number of rows of latex vessels. The number of rows in the cortex is characteristic of each tree, but some trees with a relatively low number have higher yielding power than other trees with nearly twice as many cortical latex vessels. In cortex renewed after tapping, the number of vessels remains about the same. A count of the vessels gives a better measure of the yield in older trees than in very young ones.

Lime on the Farm.—The Ministry of Agriculture has issued a revised edition of Leaflet No. 170, on the use of lime in agriculture. The practice of liming or chalking, though one of the oldest in British agriculture, has tended to be neglected during the last half-century, and the farms of to-day are suffering in consequence. The functions of lime are so numerous that it can be regarded as an all-round soil improver. Besides being an essential plant food, its presence is necessary to render artificial manures effective, and further, it acts as a corrective for soil sourness or acidity and greatly improves the working properties of heavy soil. Regular applications of lime are recommended, as a number of factors cause its depletion in the soil, and although crops vary as to their dependence on the lime supply, a well-limed soil yields more trustworthy results during critical periods of the season's growth. A need for lime may be indicated by the prevalence of certain weeds, *e.g.* spurrey, or plant diseases, *e.g.* finger-and-toe. A large number of the different forms of lime available are given, and their comparative values indicated, together with information as to the special points to be observed in the use of each form, and caution is advised as to the application of some waste lime products or lime rich in magnesia. The most suitable material to supply depends largely on the cost, but carbonate of lime can give as good results as burnt lime provided it is sufficiently fine and well distributed in equivalent quantity. Further, ground limestone and chalk have the additional advantage over lime in not deteriorating on storage, and in their harmlessness if applied to a growing crop. The time and method of application should be chosen with the view of ensuring the most perfect distribution. The quantity necessary to apply varies widely with the form of lime applied, but an average dressing of 10 cwt. to 1 ton per acre of ground lime, or 1 to 2 tons per acre of carbonate of lime once in four or five years is suggested.

The Genus Clementia in American Tertiaries.—Apart from its value as a zone fossil in American Tertiary deposits, the chief interest of the genus Clementia (fam. Veneridæ) lies in the anomalous features of its present and former distribution. Mr. W. P. Woodring now seeks to trace its geological history, its palæobiological significance, and to describe all the known American species (U.S. Geol. Survey, Professional Paper 147—C). Eight forms, species and subspecies, with two doubtful species, are described and figured on four excellent plates. There is also a text map of the world marked to show the present range and past distribution of the genus.

The Molluscan Genus Gisortia.—When last year (Nature, vol. 117, p. 246) we recorded a posthumous paper by the late Dr. Vredenburg (died 1923) on the post-Eocene Mollusca of the Tertiary formations of north-west India, no further contribution from his able pen was anticipated. Now, however, a belated monograph by him on the cowry-like genus Gisortia has been published (*Mem. Geol. Surv. India: Palæont. Indica*, New Series, vol. 7, mem. 3). The generic name dates only from 1884, but so far back as 1825 one fossil and one recent representative were described. The latter, the Australian *Cypræa umbilicata* of Sowerby, remains the unique living example; but Dr. Vredenburg has described thirty-six species in all, going back in time to the Cretaceous period, many only known in the condition of internal casts. All are figured of the natural size on thirty-one photo-plates, and tables given of their stratigraphical distribution and probable zoological affinities. Judging from internal evidence, this monograph would appear to have been completed about 1917.

Earthquake Prediction in California.—The question of earthquake prediction is receiving renewed attention in the United States. After the San Francisco earthquake of 1906, two rows of four pillars each were erected across the San Andreas rift, along which the great movement occurred. Dr. J. P. Buwalda now proposes to extend the series so as to cover southern California, and the work is to be carried out under his guidance by the California Institute of Technology, in co-operation with the Carnegie Institution of Washington (*Daily Science News Bulletin*, Washington, No. 313 B). The monuments will be erected in straight lines across suspected earthquake-faults. If, after five or ten years, the lines remain straight, it will be concluded that no great earthquake is in prospect there; but if the line should be distorted into the S-form, the situation will then be regarded as dangerous.

Tides and Currents in Alaska.—The United States Coast and Geodetic Survey has issued the fourth volume in a series of publications on tidal and current observations made in the more important waterways in United States territory. Special publication No. 127 deals with south-east Alaska and is the work of Lieut. R. W. Woodworth and F. J. Haight. Tidal stations of some standing are now sufficiently numerous on this coast to permit of the discussion of tides for the main ship channels and principal parts. Unfortunately, there are as yet no stations in Glacier Bay, to the east of Lynn Channel, where the Alaskan glaciers that reach the sea must have a disturbing effect on the tides. Current observations, though of comparatively short duration, show a general north-westerly set in the waterways of south-eastern Alaska. The authors attribute this inshore current to a back eddy of the westerly drift across the north Pacific. The larger part turns south-east along the coast of North America, but a smaller part turns north and is driven into the inland passages by the prevailing westerly winds. The volume contains a useful appendix, reprinted from an earlier publication, on the general characteristics of tides and currents.

Pedestal Rocks formed by Erosion.—An interesting contribution to physical geology is made by Kirk Bryan in Bull. 790 A of the U.S. Geological Survey, where he deals with pedestal rocks formed in arid climates by differential weathering. It is shown that many other processes are operative besides wind abrasion, and examples attributed to chemical weathering, temperature changes, differential rainwash and sapping are described. Such processes are also operative in humid regions, but the life of the pedestals there developed is relatively short because of the rapidity of rock decay, and in the colder regions also because of the increased effectiveness of frost action. Moreover, in humid regions the formation of soil and the prevalence of vegetation inhibits the growth of pedestals except when the conditions are especially favourable, as for example when glacial erratics of insoluble rocks rest on a limestone platform.

Two Shallow Oilfields in Texas.—On Mar. 8 Dr. Arthur Wade read a paper before the Institution of Petroleum Technologists on the Sipe Springs and Deep Creek oilfields of Texas, both developed in what is technically known as the South Mid-Continent region. In the case of Sipe Springs the area is essentially an inlier of Pennsylvanian (Canyon member) rocks surrounded by Cretaceous deposits, the relationship between the two formations being that of unconformability and overlap. The structure of the field is simple, the beds dipping west at an almost imperceptible angle, with indication of a terrace running from north to south; in this the field resembles many other South Mid-Continent oilfield structures, where often the appreciation of dip is only obtainable by levelling over a wide area. Oil is produced at Sipe Springs from two sands, one at 180 ft. to 200 ft. below the surface, the other 260 ft. to 300 ft.; the former sand is lenticular and production from it is erratic; the latter is a more persistent horizon and is productive throughout the field. In common with other fields in this region, the origin of the oil is doubtful: it may either be indigenous to one of the members of the Pennsylvanian, or it may have originated in the underlying Bend group (Mississippian) from which extensive migration is known to have occurred. In the Deep Creek field the critical formation is that of the Putnam group, mainly clays with lenticular sandstones, shale, and limestone of rather uncertain age, lying between the Cisco member of the Pennsylvanian and deposits known to be of Permian age. The sandstones contain oil and gas, also salt water. The structure is not unlike that of Sipe Springs, but the westerly dip is slightly steeper. The Sipe Springs oil is of good quality with an average gravity of 0·83; that of the Deep Creek field is similar; in fact, considering that the oil of these fields is derived from distinctly different formations, the similarity of physical and chemical properties in both cases is remarkable.

LARGE VACUUM TUBE.—What is stated to be the world's largest vacuum tube, constructed by the General Electric Co. of America, has now been in use in a radio station for several weeks. It is seven and a half feet high and weighs 100 lb. It is rated at 100 kilowatts, and is kept cool by a copper jacket through which water is kept circulating. It takes the place of eight 20-kilowatt tubes, which were formerly used. Hitherto 50 kilowatts has been the maximum power given to the antenna of a 'super-power' radio station. A battery of the new tubes will permit experiments with 500 kilowatts in the antenna. This is one thousand times the power used by a typical broadcasting station three or four years ago. Two ounces of tungsten are used in the filament, which is as thick as the lead in a lead pencil, and is eight feet long.

DENSITY OF THE PHOTOGRAPHIC IMAGE.—In two papers in the *Proceedings of the Royal Society of Edinburgh* (vol. 45, pt. 2, p. 166; 47, pt. 1, p. 34) Dr. E. A. Baker describes in detail the large amount of experimental work carried out by him in connexion with Prof. Sampson's investigations on the temperature of a great number of stars by determining photographically the distribution of energy in their spectra. Dr. Baker's work consists essentially in a rigid calibration of the particular types of photographic plates used by Prof. Sampson, so that the true interpretation in terms of intensity can be given to the densities obtained on the plates when the time of exposure, the conditions of development, and wave-length of the light are varied. The author starts with a perfectly general expression connecting the intensity with the variable factors density, exposure time, and wave-length, and finds it convenient to consider two characteristics of the plates, which he calls p and q, and to determine how they are affected by variation in these factors. p is the so-called Schwarzschild constant and q is analogous to γ, the slope of the characteristic curve, and at higher density values is equal to p/γ. Amongst other interesting results it is found that for a constant blackening and constant exposure time, the variation of p with wave-length is very small, a result which is to be expected if p depends on the value of the effective intensity (*i.e.* the energy absorbed by the plate per second) and if equal effective intensities of different wave-lengths produce densities of the same order. The larger part of the second paper is devoted to a new theory of the relation between the number of grains of silver halide affected, the intensity of the incident light, and the duration of the exposure (see also NATURE, Sept. 11, 1926, p. 374). Without entering here into the details of the theory the conclusion is, to quote Prof. Sampson, "that the initial stages of the photographic action, including the deviations from the reciprocity law, are calculable and well represented by assuming that the developable product is formed in two stages, each stage requiring one quantum, and that the product of the first stage returns in the absence of further stimulus to its original sensitive state, according to the law governing the progress of a mono-molecular change." The idea involves, apparently, two distinct kinds of absorbers of energy in the silver halide grains, one for each stage.

CALCIUM IN ALUMINIUM CONTAINING SILICON.—Mr. J. D. Grogan read a paper at the recent spring meeting of the Institution of Metals on "The Influence of Calcium on Aluminium containing Silicon." The addition of calcium to aluminium results in the formation of a compound, $CaAl_3$, which is very slightly soluble in solid aluminium. By the addition of silicon to this alloy, the compound $CaSi_2$ is formed, which is practically insoluble in the solid state at all temperatures. Neither compound appears appreciably to improve the mechanical properties of aluminium, or to impart age-hardening properties. The addition of suitable quantities of calcium to aluminium containing silicon improves the electrical conductivity by removing silicon from solid solution. As the effect of $CaAl_3$ on the conductivity of aluminium is relatively small, the effect of a slight excess of calcium is not harmful.

MOLYBDENUM IN NICKEL-CHROME STEELS.—Report No. 67 from the Research Department, Woolwich, on "The Influence of Molybdenum on Medium Carbon Steels containing Nickel and Chromium," shows that the addition of molybdenum to nickel-chrome steels raises the AcI point but lowers ArI. In many cases the Ar point is depressed to 470° C.—Ar″—unless the rate of cooling is very slow. Molybdenum has a more powerful effect than nickel or chromium in reducing the liability to imperfect hardening when the rate of cooling is slow, and reduces the softening on tempering. About 0·5 per cent. of molybdenum is sufficient to bring about most of the possible improvement in these steels. The 'mass-effect' is reduced by the presence of the third alloying element, when the mechanical results show great uniformity even in the biggest forgings. Tests can be repeated with great regularity, indicating that the steels are unaffected by slight departures from standard conditions of treatment. The elastic properties, ductility, and impact value are all improved by the addition of molybdenum, which has the further great advantage that it has a pronounced effect in considerably reducing, or completely eliminating, the susceptibility of the steel to 'temper-brittleness.' Nickel-chrome-molybdenum steels provide the best all-round combination of properties, though nickel-molybdenum and chrome-molybdenum steels approach them nearly. When treated so as to give a tensile strength of 50 tons-60 tons per sq. in., the best composition from these three types of steel—in each case with a carbon content of 0·3 per cent.—are as follows: Nickel-chrome-molybdenum: Nickel 2·6 per cent., chromium 0·6-1·1 per cent., molybdenum 0·6-0·4 per cent.; steels in this range of composition all gave very similar properties when tempered to the same hardness, the higher chromium content being an advantage when a tensile strength of 60 tons per sq. in. or more is required. Chromium-molybdenum: Chromium 1·0-1·5 per cent., molybdenum 1·0-0·5 per cent.; slightly inferior in general properties but gives higher notched-bar impact figures. Nickel-molybdenum: Nickel 2·7-4·0 per cent., molybdenum 0·6-0·4 per cent.; rather better in yield ratio than the nickel-chrome-molybdenum steel but inferior in impact value; when the nickel exceeds 3 per cent., as is necessary to obtain a tensile strength of 60 tons per sq. in., these steels show distinctly lower impact values and also become difficult to machine.

The Embrittlement of Boiler Plates.

THAT boiler plates may become brittle in the course of time and in certain circumstances is now a well-established fact. All the conditions, however, which govern the phenomenon are by no means completely known, and the problem raises points both of great practical and of scientific importance. A paper entitled "The Cause and Prevention of Embrittlement of Boiler Plates," by S. W. Parr and F. G. Straub, Bulletin No. 155 of the University of Illinois Engineering Experiment Station, which deals with the subject at some length, is therefore of considerable interest.

It is first shown that of the recorded examples of brittle boiler plates in America, there are certain areas where the trouble is more evident than in others. This at once suggests that the water is the cause of the failures, and this is strengthened by the fact that in these localities the waters used are characterised by an almost complete absence of sodium sulphate and by the presence of free sodium bicarbonate. It is to the latter salt that the authors attribute the primary responsibility for the embrittlement. The type of boiler used is not believed to have any influence, since failure due to brittleness has occurred in a considerable number of different makes and designs, both fire- and water-tube. Further, the writers reach the very interesting conclusion that the steel from which the plates are made has *per se* no effect either. Their reasons for coming to this conclusion are as follows: Six different types of steel which had become brittle in actual boiler service were examined. The carbon content ranged from 0·14 to 0·26 per cent., the manganese from 0·26 to 0·54, the phosphorus was consistently low, and the sulphur varied from 0·018 to 0·046 per cent. Micrographic examination also indicated that good steel was just as liable to fail as low-grade, dirty material. In the experimental work described, steels were investigated in which the range of composition was:

Carbon	0·023-0·30	per cent.
Manganese	0·017-0·45	„ „
Sulphur	0·007-0·027	„ „
Phosphorus	0·003-0·012	„ „

Apart from the question of the yield point, variation of the composition of the steel within this range had very little, if any, effect on the rate of embrittlement.

The experimental work on short-time, accelerated tests confirmed what had been previously believed, namely, that stress and the nature of the solution each played essential parts in causing brittleness. So far as the former factor is concerned, it is shown that this must exceed the yield point of the steel before failure commences. There are also indications that, provided this stress intensity is attained, the actual value of the stress is not of prime importance. As, therefore, the yield point of the material is raised, so will also be the stress to which the steel may be subjected in service without failure due to brittleness ensuing. Thus 3·5 per cent. nickel steel showed in the tests no abnormality other than the increased stress required to induce embrittlement. A steel severely cold-worked previous to test also appeared to require a rather higher stress to initiate the trouble than the same steel in the annealed condition. In connexion with the latter factor the temperature used in the annealing of the steels had very little effect. A fact recorded which is, however, somewhat difficult to reconcile with the foregoing is that with high sulphur and phosphorus contents the steel is more liable to become brittle; for example, a decided increase in the rate of embrittlement is recorded for a material with 0·215 per cent. of sulphur and 0·126 per cent. of phosphorus compared with normal steel. The explanation offered for this effect of these elements is not convincing.

The examination of the surface of embrittled plates shows no corrosion, but there is, as in all cases, a layer of magnetic oxide of iron. So long as this is compact and complete, further attack on the metal is inhibited, but if for any reason the coating is broken, the unprotected metal surface is then again laid open to chemical attack from the solution. The importance of the yield-point stress is thus apparent. Under this stress there will be sufficient plastic deformation of the metal to fracture the oxide film and the attack will recommence.

So far, then, as the prevention of this embrittlement is concerned, one of the methods by which this could be done would be by cutting down the actual stress to a value below the yield point. This the authors regard, however, as being impractical. The failure is associated with the seams where the different plates are riveted together, the cracks produced running in general from one rivet hole to another and not extending into the body of the plates beyond the lap of the seam. Now, both in the operation of riveting and under the conditions of service, greatly concentrated, localised stresses must occur in such positions, and stresses exist there considerably exceeding the yield point even when the steel plate as a whole is far below its yield stress.

It follows, therefore, that the only effective protection will come from the consideration of the water used. As has already been mentioned, the characteristics of those natural waters which in the United States have led to this type of failure are the presence of sodium bicarbonate and a low concentration of the sulphate. In time, then, a caustic condition will be set up in the boiler with the sodium hydroxide in excess of sodium sulphate, and it is to this caustic soda directly that the embrittlement is ascribed. The reaction assumed to be responsible is represented by the equation

$$3Fe + 4OH' = Fe_3O_4 + 4H^{\cdot}.$$

The hydrogen then passes into solid solution in the steel and leads to brittleness. This attack is shown to be a surface phenomenon by measurement of the e.m.f. of the original and brittle steel against caustic soda solutions and by the grinding off of the affected surface, when the e.m.f. value becomes again that of the untreated steel. In accelerated tests it was shown that a concentration of 350 gm. of caustic soda per litre is required to initiate the failure. This value, it is supposed, may in time be reached between the plates where they overlap, but it is also realised that such figures from accelerated tests need not necessarily apply to conditions in service, and that under prolonged application of stress even lower concentrations may be equally important.

Passing on to consider the treatments of the water which are possible and would lead to inhibition, the authors' view is that neutralising the alkalinity of the water with sulphuric acid could not be carried sufficiently far without endangering the boiler. It was found, however, that increasing the concentration of sodium sulphate or carbonate in relation to that of the hydroxide retarded and eventually prevented the attack. This effect has been studied for several years on an actual boiler, in which the feed-water was maintained with a ratio of sulphate to carbonate of 2 by neutralising about 70 per cent. of the alkalinity with sulphuric acid. After ten years of operation the boiler is in perfect condition, whereas a similar plant using, apart from the water treatment, identical conditions, was condemned after nine years.

It is clear, however, that the treatment must be done under expert supervision. The same applies equally to the addition of aluminium or magnesium sulphate. This treatment is very effective when used in connexion with settling tanks and filters which remove the possibility of scale-forming ingredients entering the boiler, but if used in excess, the salts are distinctly harmful and the quantities added need careful control. Undecomposed sodium carbonate acts as an inhibitant, and cases are on record where the sulphate-carbonate ratio of the water was exceedingly low without any indications of brittleness due to high sodium carbonate content. It is, however, well to regard the carbonate as the potential source of the hydroxide. The authors finally consider that the best ratio to adopt as standard in water treatment for boilers is that of the combined sodium sulphate and carbonate to the hydroxide. Although they are not yet prepared to suggest hard and fast figures, they believe that when this ratio exceeds 2, it is sufficient to stop the embrittlement.

F. C. T.

Whales and Dolphins.[1]

THE scientific heads of the British Museum for many years (just as Dr. R. Knox, Prof. Goodsir, and Principal Sir William Turner did in the northern capital) have devoted much attention to the cetaceans, as seen in Dr. Gray's Catalogue, Sir R. Owen's *Kogia*, and the important publications of Sir William Flower—to whom the public owe the interesting Whale Gallery at the Natural History Museum, South Kensington, with drawings from life by his daughter. It was, however, reserved to the director who has just retired, Sir Sidney Harmer, to systematise the means for obtaining information of all the species—of this most intelligent and interesting as well as much persecuted group—caught or stranded on British shores. In the publication before us he has further added to the indebtedness of the public and men of science by summarising the results of his labours, which, by aid of the officials of the Board of Trade and others, have largely extended our information.

In few groups are there more striking examples of maternal solicitude than in the Right whale, or more conspicuous social instincts than in the Pilot whale. Such is proved by the cruel methods of the old whalers in harpooning the helpless young in order to secure the anxious mother, whilst in the latter group a single example will suffice—thus when more than two hundred were embayed with their leader, an old male, in Scalloway harbour (a kind of pocket with a narrow entrance), the leader dashed through both the inner and the outer cordons of boats and reached the open sea, but when he found he was alone he turned shorewards, again rushed past both lines of boats, and was killed in the midst of his followers in Scalloway harbour, where to this day their skulls make suitable wedges to support the boats.

The first part of Sir Sidney's memoir gives practical information as to measurements of specimens, the different kinds of Cetacea and their sex-characters, illustrated by excellent figures. A brief account of toothed and whalebone whales follows. As an appendix to the list of porpoises, the fact is recorded that in summer in Shetland no less than 100 to 150 may occasionally be seen disporting themselves close inshore in Bressay Sound—probably attracted by a shoal of fishes. The female porpoise gives birth to her young often in June, and she may be watched swimming in circles close inshore with it, or resting on her side with a flipper in the air as it suckles. To Sir Sidney's remarks on the various forms it may be added that some of the larger dolphins occasionally 'breach' like the Humpback whale from the side of a huge wave, again noisily striking the water. The Killer, besides occurring on the east coast, may often be seen in the Sound of Raasay, not far from Portree in Skye, the long dorsal fin projecting above water, steadily propelled as if from a powerful screw.

The author makes important remarks on Cuvier's whale, formerly thought to be rare, especially in connexion with the prenarial basin of the male, about which he hazards the reasonable view that it "is occupied by derivatives of the two narial passages, perhaps diverticula which lie in the basin and are separated ventrally by the reduced prenarial part of the mesorostral." He also discusses skin-markings of whales, with remarks on age and disease, and the sizes of the newly born—quoting from Mr. R. C. Haldane's paper of 1905 (*Ann. Scottish Nat. Hist.*, No. 54) the fact that the young Finner when born is about 20 feet long, and that "sucking calves of 40 feet have been seen."

Tables follow with the Cetacea stranded in 1925 and 1926—27 in the former and 47 in the latter year. In his brief remarks on some of these the author observes that a white-sided dolphin caught in the beginning of August in the Loch of Stenness (near Stromness) at a time when Salps in large numbers pass from the Atlantic to the North Sea may have been attracted by them. Unfortunately, the contents of the stomach were not reported. This view would interest some in connexion with the Fishery Board for Scotland, who took the view that the hordes of Salps ousted the herrings from their usual haunts, the fact being that herrings and other fishes (if not whales) have, like birds and many invertebrates, a relish for Salps or part of them.

Under the tenth head a summary of the characters of the British toothed and whalebone whales, and a key for determining species, are given—a useful guide for all who come in contact with them, especially in such cases as True's Beaked whale, which has only occurred twice on the coasts of Britain.

Appended to the report are seven very useful quarto maps of the British Isles, the first indicating the stations where all the Cetacea during 1925 and 1926 were obtained, the field being generally dotted—with perhaps a denser grouping in the north. The second map is devoted to the common Dolphin, with maximum stations for 1913–1926 to the south and west, the latter areas also being in the ascendant for the Bottle-nosed and the White-beaked Dolphins. The other maps for the Killer, Hyperoodon, Cuvier's, Sowerby's, and True's Beaked whales, as well as the whalebone and spermaceti whales, are equally instructive for the period.

In dealing with the scientific names of the various species, the author throughout has unfortunately refrained from adding the name of the authority for each, probably to avoid complication.

The publication of this report will do much to facilitate the recognition of cetaceans by the public as well as to afford useful information to men of science, and Sir Sidney Harmer is to be congratulated on his statistical and other labours, and the completion of so important a summary. It is to be hoped that his methods will be continued by the Museum on similar lines in future. Both in this respect and in his influence and exertions in connexion with the arrangements for the expedition in the *Discovery* and *William Scoresby* to the Falkland Islands in search of further knowledge of the life-history of the cetaceans, science and the public are deeply indebted to him. W. C. M.

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[1] Report on Cetacea stranded on the British Coasts from 1913 to 1926. (No. 10.) By Sir Sidney F. Harmer. Pp. 91+7 maps. (London: British Museum (Natural History), 1927.) 7s. 6d.

University and Educational Intelligence.

Aberystwyth.—Prof. H. Stuart-Jones, Camden professor of ancient history in the University of Oxford, has been appointed Principal of the University College of Wales.

London.—Three public lectures on "Some Surgical Problems" will be given at the Middlesex Hospital Medical School at 5 o'clock, on May 16, 17, and 18, by Prof. J. Fraser. A course of four public lectures on "Inflammation and Infection" will be given at Guy's Hospital Medical School at 5.30, on May 20, 27, and 31, and June 3, by Prof. E. H. Kettle. No tickets will be required.

Manchester.—Applications are invited from persons born in or inhabitants of the County of Lancaster, preferably the County Borough of Rochdale, for the Sir Clement Royds memorial scholarship in chemistry in the University of Manchester, the value of which is £300. The applications should be sent by, at latest, June 1 to the Registrar.

Oxford.—A public lecture will be given by the Right Hon. Sir John Simon, M.P., on Saturday, May 7, at 12 noon, on "The Labrador Boundary."

The Romanes Lecture for 1927 will be delivered by Sir Frederic George Kenyon, Director and Principal Librarian of the British Museum, at the Sheldonian Theatre on Friday, June 17, at 5 P.M., on the subject of "Museums and National Life."

St. Andrews.—The Senatus Academicus has resolved to confer the honorary degree of LL.D. upon Sir Richard Gregory and upon the Right Hon. Sir Alfred Mond, P.C., M.P., at the graduation ceremonial to be held on June 28.

Mr. G. J. Robertson has been appointed to the senior lectureship in the Chemistry Department of the United College of St. Salvator and St. Leonard, in succession to Dr. G. McOwan.

The Salters' Institute of Industrial Chemistry is inviting applications, until June 1, for a limited number of fellowships, each of the normal value of from £250 to £300, from chemists of post-graduate standing who are desirous of adopting a career in industrial chemistry; also, until June 10, for a limited number of grants-in-aid to young men and women employed in chemical works in or near London who desire to extend their education for a career in chemical industry. The applications should be sent to the Director of the Institute, Salters' Hall, St. Swithin's Lane, E.C.4.

The London School of Economics is making arrangements for a series of lectures and discussion classes on the ethnography of Africa. During the summer term Prof. C. G. Seligman will give a course of lectures on "The Nile Valley and its Peoples." In the Michaelmas term of the session 1927–28 Mr. J. H. Driberg will give a course on "The Ethnography of East-Central Africa," and will deal with the ethnography of West Africa and also with the reactions of primitive African cultures to economic development in the following lent and summer terms whilst arrangements will also be made for Mr. I Schapera to give a course on the ethnography of South Africa. Further details of this and other lectures on ethnology can be obtained on application to the Secretary of the School.

University College, London, celebrates this year the hundredth anniversary of its foundation. On April 30, 1827, the Duke of Sussex laid the foundation-stone of what was in the first instance styled the University of London but was incorporated by Royal Charter in 1836 under the name of University College London. Another separate body was chartered on the same day as the University of London, with power to grant degrees in arts, laws, and medicine after examination, to candidates who should present certificates of having completed the requisite courses at University College and such other institutions as might be approved for the purpose. To-day, with more than three thousand students, including five hundred post-graduate and research students, and its graduation list of nearly three hundred, it has an importance not less than that of many full-fledged universities. Attracting students from many countries both within and outside the British Empire, it has a cosmopolitan character and makes its influence felt throughout the world. It is marking the completion of its first hundred years by a campaign for raising half a million sterling towards building and equipment and better endowment.

In the Report of the Imperial College of Tropical Agriculture, Trinidad, 1925–26, the Principal, Dr. H. Martin Leake, gives an account of the lines upon which the College is developing. The completion and occupation of the new buildings is an outstanding feature of the past year; but owing to the increasing number of students, further accommodation is already required. A residential hostel is in course of construction but is not yet completed. The field from which students are drawn is widening; in the past year four came from the Union of South Africa and one each from Brazil, Egypt, and Ecuador respectively, in addition to those from the West Indies and Britain. At the same time students who have passed through the College are becoming widely distributed throughout the British Empire. The shortage of staff has again seriously restricted the output of research work, but the issue of the Fruit Report drawn up by the Imperial Economic Committee is an important feature. A large section of the work has been devoted to the subject of bananas, the question of greatest importance being to secure a variety immune from Panama disease and also of satisfactory carrying capacity. The Giant Fig fulfils the first of these requirements, but much further work is necessary before the optimum conditions for shipment can be determined. The serious problem of the froghopper pest of sugar-cane has also been actively investigated. The degree of attack is to a great extent dependent on the physiological condition of the plant, so that much fundamental work has to be done before the intimate relation between host and parasite can be elucidated. Such studies, however, will probably have an important influence on allied problems. Tobacco investigations have been extended, but the inadequacy of curing facilities has proved a hindrance.

Calendar of Discovery and Invention.

May 8, 1654.—One of the most striking demonstrations in physical science made during the seventeenth century was that of Otto von Guericke, who on May 8, 1654, before the assembled princes at Ratisbon, showed his great experiment with the big Magdeburg hemispheres which, when exhausted of air, could not be pulled asunder by sixteen horses.

May 8, 1795.—Though the planet Neptune was not discovered until 1846, yet it was shown as a star in Harding's Atlas of 1822, and on May 8 and 10, 1795, Lalande had also registered it as a star.

May 9, 1865.—The first application of hydraulic power to machinery was due to Lord Armstrong; but its application to machine tools was due to Tweddell who, on May 9, 1865, patented a hydraulic riveter for fixing the ends of boiler tubes. In the same year he also designed hydraulic riveting plant for a Newcastle firm, enabling machine riveting to be carried out at one-seventh of the cost of hand riveting.

May 10, 1752.—Dalibard, the French botanist, was the first to draw electricity from a thundercloud. By means of an insulated rod forty feet long fixed in a stand, on May 10, 1752, when a thundercloud was overhead, sparks were drawn from the rod, leading Dalibard to write, "Franklin's idea ceases to be a conjecture. Here it has become a reality."

May 11, 1671.—On this day Nehemiah Grew's "Anatomy of Plants begun" was read before the Royal Society and ordered to be printed. It was published the following year, and later was translated into Latin, French, and Italian. In 1682 it was incorporated in the author's larger work, "Anatomy of Plants." With Malpighi, Grew shares the honour of the foundation of plant anatomy.

May 12, 1881.—In the Berlin Exhibition of 1879 an electric railway, one-third of a mile long, was shown in operation, and similar demonstration lines were installed in other exhibitions. The first permanent electric railway was that from Berlin to Lichtenfelde, which was put into operation on May 12, 1881. Electricity at 100 volts was utilised, one rail being positive and the other negative.

May 13, 1731.—After spending some years in effecting improvements in reflecting telescopes, which led to their wide adoption, John Hadley turned his attention to instruments for measuring angles, and on May 13, 1731, read to the Royal Society a paper entitled "Description of an Instrument for taking Angles." By the introduction of the use of two mirrors, Hadley was for the first time able easily to measure angles subtended by distant objects, independently of small changes in the position of the observer.

May 14, 1796.—Jenner's famous experiment in inoculation was made 131 years ago. He had long desired to try the passing of the vaccine virus from a human being to another by the ordinary mode of inoculation, and on May 14, 1796, a boy named Phipps was inoculated in the arm from a pustule on the hand of a dairymaid, Sarah Nelmes, who was infected by her master's cows. Writing a little later, Jenner said, "But now listen to the most delightful part of my story. The boy has since been inoculated for the smallpox which, as I ventured to predict, produced no effect."

May 15, 1836.—It was during the annular eclipse of the sun of May 15, 1836, that Francis Baily saw the phenomena called "Baily's Beads," of which he gave a very striking description. Though in later eclipses the "Beads" were not so vividly seen, Baily's account did much to stimulate attention to the physical aspects of solar eclipses.

E. C. S.

Societies and Academies.

LONDON.

Royal Meteorological Society, Mar. 20.—**R. A. Watson Watt**: The range of atmospherics (Report of the Committee on Atmospherics and Weather). The distances over which an atmospheric may produce disturbance of broadcast reception was discussed. The Committee organised experiments in which observers in the British Isles, Norway, Germany, France, Spain, Morocco, and Madeira recorded disturbance of broadcast talks, while the sources of the atmospherics were identified by radio position-finding by the organisation set up by the Department of Scientific and Industrial Research on the advice of its Radio Research Board. Many of the sources were found to lie in regions of meteorological disturbance. Atmospherics from beyond the Azores have disturbed the reception of Daventry's signals in Paris and of London's signals in Aberdeen, and a thunderstorm at Rome disturbed reception in Spain, France, Madeira, the British Isles, and Norway. Many atmospherics are heard at distances exceeding 1800 miles from their sources, and may reach at least 4500 miles. There is no evidence of the presence of many atmospherics with a short range of disturbing effect.

Geological Society, April 6.—**Vincent G. Glenday** and **John Parkinson**: The Kateruk series and associated rocks of the northern Suk Hills (Kenya Colony). A series is described of completely metamorphosed sediments which crop out on or near the Kateruk River, an eastward-flowing tributary of the Turkwal River, situated about 30° 15′ long. E. and 2° 37′ lat. N., in the north-western part of Kenya Colony. The rocks consist of the metamorphosed representatives of various sedimentary deposits, ashes being included. The constituents indicate a somewhat lower grade of metamorphism than those of the Turoka series of the south, and may prove to be slightly younger.—**H. L. Hawkins** and **Miss S. M. Hampton**: The occurrence, morphology, and affinities of the Silurian Echinoidea Echinocystis and Palæodiscus. Church Hill Quarry, near Leintwardine, was re-opened, and a careful record of the sediments was made. A column of rock was excavated to a depth of 12 feet 6 inches from the surface. The beds traversed are all calcareous flaggy mudstones, varying slightly in lime-content. Ripple-marked surfaces were found at two horizons. Fossils are very rare, except in congested bands. The series seems to have accumulated in shallow lagoon-water, and the indigenous fauna of echinoderms and Lingulæ was periodically reinforced by brachiopods, pteropods, and graptolites drifted in during storms. New material of Echinocystis and Palæodiscus, including specimens which show obverse and reverse casts, and others showing upper and under surfaces of the test, has made it possible to solve many of the problems associated with the genera. Echinocystis is revealed as a typical perischœchinoid, with a normal endocyclic apical system and an advanced complexity of ambulacral structure. In Palæodiscus, the indications of an endocyclic apical system seem convincing. The reputed 'Asteroid' ambulacral plates are knob-like ingrowths from the perradial zones of the otherwise normal plates. Both genera are claimed as advanced perischœchinoids—far too specialised to show pre-echinoid features.

Society of Public Analysts, April 6.—**C. Ainsworth Mitchell** and **T. J. Ward**: The sequence of strokes in writing. Systematic experiments have been made to determine to what extent one may trust to the appearance of one of two intersecting lines being uppermost as a proof that it was made more recently than the other. The appearance coincides with the fact in the case of insoluble opaque pigments such as lead pencil, but is deceptive with a transparent pigment such as an aniline dye. The relative position of lines made with writing inks which undergo oxidation, and thus form an opaque insoluble pigment, can usually be accurately determined, but if the ink has been blotted the observation is, as a rule, untrustworthy.—**D. W. Kent-Jones** and **C. W. Herd**: (1) Observations on the washing of gluten from flour. The use of a special washing solution does not eliminate the errors inherent in gluten determinations. Even when the same amount of washing water is used and the same procedure followed, personal differences in the manipulation of the dough and gluten cause large variations in the result. Each operator, however, gets essentially consistent results, which means that the ratio between the nitrogen of the flour and the dried gluten is approximately constant for each worker. (2) A numerical expression for the colour of flour. The yellow colouring matter is extracted by means of petroleum spirit, and its colour measured in a special form of colorimeter. This figure indicates the natural whiteness, or alternatively, the artificial bleaching of the flour. The grade of the flour may be judged by the amount of the reddish-brown pigment present which, presumably, comes from the finely powdered offal. This pigment is determined in the colorimeter after extraction with alkaline methyl alcohol.—**H. B. Dunnicliff** and **Kishen Lal**: The determination of free mercury in commercial products. The main constituents of the substance containing free mercury are removed by extraction with a suitable solvent. The residue is treated with bromine water, the resulting mercuric bromide is dissolved in alcohol, and the mercury is precipitated as mercuric sulphide, which is filtered off and weighed in a Gooch crucible.

Paris.

Academy of Sciences, Mar. 28.—**G. Friedel**: The recent controversy between MM. Hettich and Valeton. Holoaxial hemihedral forms do not necessarily imply the hemihedry of the crystal.—**Norbert Wiener**: A new method for the demonstration of Tauber's theorems.—**Julius Wolff**: A generalisation of a theorem of H. Jentzsch. — **Sugot**: The gyroscopic movement of the projectile near the mouth [of the gun].—**R. Mazet**: The flow of a liquid starting from rest in a liquid of the same density in steady motion.—**Huguenard, Magnan**, and **V. Sainte-Laguë**: The kinematographic determination of the polars in the flight of birds, gliders, and aeroplanes.—**E. Carafoli**: The movement round a plane plate in rotation.—**Louis Breguet**: Long flights without stops and the distance record in an aeroplane. — **Rateau**: Observations on the preceding note.—**Th. De Donder**: The physical interpretation of the equation of quantification of continuous systems.—**Jean Jacques Trillat**: The analytical interpretation of the X-ray spectra of the fatty acids and their mixtures. The same spectrum is always obtained from a pure or nearly pure acid if the preparation is made by fusion on a glass plate or by evaporation from an alcoholic solution. With mixtures of fatty acids the position of the lines cannot be predicted from the known proportions of the constituents. The study of a mixture of fatty acids fused on glass does not give the qualitative composition of the mixture, but more definite results are obtained when lead is substituted for glass.—**A. Boutaric** and **Mlle. G. Perreau**: The possibility of modifying at will the electrical sign of colloids.—**Maurice Lecat**: Formulæ for predicting the azeotropic constants of systems formed of an alcohol and an alkyl halide.—**René Girard**: The action of complex saline solutions on the ferrous metals. With a mixture of salts in solutions, such as an artificial sea-water, the net result depends on the texture of the corrosion products.—**Marcel Godchot**: Some syntheses of glycols containing the ether oxide grouping. —**André Kling** and **Daniel Florentin**: The hydrogenation of naphthalene and of anthracene at a high temperature and under high pressure in the presence of non-hydrogenating catalysts. Results of experiments are tabulated shewing effects, on yields and nature of hydrocarbons produced, of varying pressures of hydrogen, and also the effect of adding a catalyst.—**Barré**: A new method of preparing α-ketonic acids. The interaction of ethyl magnesium bromide on ethyl diethyloxamate, $C_2H_5 . O . CO . CO . N(C_2H_5)_2$, gives rise to two products, the diethylamide of α-ethyl-α-oxybutyric acid $(C_2H_5)_2 C(OH) . CO . N(C_2H_5)_2$, and the diethylamide of propionyl formic acid, $C_2H_5 . CO . CO . N(C_2H_5)_2$, and the reaction can be modified to give either of these as the principal product by varying the temperature and the proportion of the magnesium compound. Propionyl formic acid can be obtained with good yields by hydrolysis of its diethylamide, and this method for the preparation of α-ketonic acids is more advantageous than those hitherto in use.—**A. Wahl** and **Féricéan**: Disulphisatide. Experiments are given proving that the double formula, $C_{16}H_{14} . O_2 . N_2S_2$, is more probable than the single formula, $C_8H_7 . ONS$ suggested by Sander.—**J. Campardou**: The general preparation of hydrocarbons by the reduction of organic substances. The use of carbon and carbon monoxide. A description of a general method of reduction based on the action of carbon monoxide at 400°–450° C., in the presence of wood charcoal as a catalyst.—**A. Demay**: The mylonitic zone of Grimaud and the prestephanian breaking away of the western part of the Maures massif.—**Georges Mouret**: The geological constitution of the Arnac-la-Poste region (Haute-Vienne).—**H. Colin**: The formation of sugar in the beet.—**R. G. Werner**: Compulsory symbiosis or independent life of the fungi of lichens.—**Jacques Rollet**: Histological researches on testicular grafts in mammals (white rat). The observations cited show that there is never a true graft.—**A. Gurwitsch** and **Mme. L. Gurwitsch**. The secondary mitogenetic radiation.—**Ch. Achard, A. Grigaut**, and **A. Leblanc**: The lipoid equilibrium of the blood serum.

Rome.

Royal National Academy of the Lincei, Feb. 6.—**G. Armellini**: Horizontal diameter of the sun in 1925 and 1926. The results of three observers give for the horizontal radius of the sun at its mean distance from the earth the mean value 16′ 0·63±0·04″ for 1925 and 16′ 0·09±0·04″ for 1926, the value being 16′ 1·03±0·04″ for 1924. These results confirm the gradual diminution in the solar diameter corresponding with the maximum of sun-spots occurring in 1927–1928.—**L. Petri**: The presence in plants of a substance which becomes luminescent in ultra-violet light. This substance, previously noted, withstands dry heat at 170° C. but is destroyed by incineration of the plant tissues. It occurs most abundantly in those organs capable of effecting the photosynthetic assimilation of carbon and possibly constitutes a factor necessary to such assimilation, although it is not an integral part of the pigments contained in the chloroplasts. It is found in subterranean organs, but only in those which form chlorophyll if exposed to light.—**M. Picone**: 'Majoration' of the integrals of ellipticо-parabolic linear equations with partial derivatives of the second order.—**E. Bompiani**: The geometry of Laplace's equation.—**Arturo Cecconi**:

theorem on the work of elastic deformation.—B. aldonazzo: An observation concerning viscous motion symmetrical with respect to an axis.—A. Weinstein: The theorem on the existence of liquid ets.—G. Rossi: Observations on the scintillation of the stars at the Royal (Italian) Observatory, Campi-oglio. The phenomenon of scintillation oscillates bout a mean condition in accordance with laws nalogous to those governing so-called casual phenomena.—A. Carrelli: The summation theory of Thomas and Reiche.—G. Piccardi: Order number, xcess weight, and atomic structure. Chemico-physical considerations concerning the relations between atomic number and atomic weight, in onjunction with astro-physical considerations, lead o the hypothesis that the excess positive and negative electrons, represented by the difference between the atomic weight of an element and twice its atomic number, are arranged outside of the atomic nucleus. It seems possible to formulate a complete theory of isotopes on this foundation.—G. R. Levi and A. Reina: Peptisation of 'meta' thorium oxide. Investigation of the process of peptisation of thorium oxide by X-ray analysis shows that the 'meta' variety of this compound has a distinctly higher degree of subdivision than the ordinary product, and that this process involves no further subdivision of the separate crystalline granules and no increase of the interatomic distances.—G. Bozza and G. Devoto: Calculation of the chemical affinity on the basis of entropy.—G. Ponte: Temperature of laval percolations from Etna. Consideration of the observations recorded by previous investigators indicates that the temperature in the bed of the flow of a stream of lava is transmitted slowly and may rise considerably in the central part where the movement is greatest, that is, where fresh hot lava is continually arriving. The extent of the cooling at the surface naturally depends on a number of factors.—P. Principi: Miocene strata between the valleys of the Lamone and Bidente.—D. Rosa: A possible variant of hologenesis.—Darwin Wen: New experiments on the hereditary behaviour of the capacity of the egg for development. Parthenogenesis in crosses between uni- and bi-voltine races of *Bombyx mori*.—G. Cotronei: The systematic biology of Petromyzon.—U. D'Ancona: Growth of the Tiber shad. The curve representing the length of this fish in relation to its age resembles a parabola, whereas the weight-age curve is analogous to that representing autocatalytic reactions according to Robertson's equation, $\log x/A-x=K(t-t_1)$. Hence, the value of k in the equation, $P=kL^3$, where P is the weight and L the length, varies with the age. The growth in length varies during different months of the year in a manner represented approximately by a sinoidal curve, which is superposed on the parabola showing the annual growth. The growth in weight also exhibits oscillations with an annual period, the amplitude being small before the attainment of sexual maturity, and considerable afterwards.

VIENNA.

Academy of Sciences, Mar. 10.—**H. Mache**: Nernst's heat theorem and the impossibility of attaining absolute zero.—**A. Kieslinger**: (iii) The stone-ovens (*Steinöfen*) of the Kor Alp region; (iv) Old and young disintegrations in the Kor Alp region.—**H. Herrmann**: The behaviour of frog's lymph towards blood of another species.—**J. Pollak, K. Deutscher**, and **M. Krauss**: The course of Leuckart's xanthogenate reaction.—**E. Blumenstock-Halward**: The action of aqua regia on fluorine.—**O. Lustig** and **E. Katscher**: The action of chlorosulphonic acid on aromatic amines.—**J. Warkany**: (i) The problem of the destruction of lactic acid by erythrocytes; (ii) The methods of determining lactic acid in urine.—**J. Lense**: A contribution to the geometry of the sphere.

Mar. 17.—**F. Quittner**: The electrolytic conductivity of glass at high voltages.—**L. Moser** and **M. Niessner**: The determination and separation of rare metals: (ix) Beryllium from aluminium. Aluminium can be precipitated along with ferric hydrate, which acts as a flocculating agent. Replacing iron by tannin, the tannin can be used to bring down the aluminium, whilst ammonium acetate retains the beryllium in solution as a complex salt.—**H. Neudorfer**: The analysis of the principal tangent curves on algebraic net-surfaces.—**A. Smekal**: Further investigations on deformed crystals of rock-salt.

Official Publications Received.

BRITISH.

Memoirs of the Geological Survey of India. Palæontologia Indica. New Series, Vol. 10, Memoir No. 1: Palæozoic and Mesozoic Fossils from Yun-nan. By Dr. F. R. Cowper Reed. Pp. iv+331+vi+20 plates. (Calcutta: Government of India Central Publication Branch.) 20.9 rupees; 33s.

Report of the Kodaikanal Observatory for the Year 1926. Pp. 4. (Calcutta: Government of India Central Publication Branch.) 6 annas.

University of Glasgow. Reports on the Hunterian Collections for the Year 1925–26. Pp. 7. (Glasgow.)

The Half-Yearly Journal of the Mysore University. Vol. 1, No. 1, January. Pp 92. (Bangalore.) 2 rupees.

Memoirs of the Department of Agriculture in India. Botanical Series, Vol. 14, No. 3: Sugarcane Breeding—Indications of Inheritance. By Rao Saheb T. S. Venkatraman. Pp. 113-129+6 plates. (Calcutta: Government of India Central Publication Branch.) 8 annas; 10d.

Rhodesian Museum, Bulawayo. Twenty-fifth Annual Report, 1926. Pp. 15. (Bulawayo.)

The Snake Park, Port Elizabeth. By F. W. FitzSimons. Pp. 82. (Port Elizabeth: Port Elizabeth Museum.)

Institution of Chemical Engineers. Some Industrial Developments and the Chemical Engineer. Presidential Address by Sir Frederic L. Nathan delivered at the Fifth Annual Corporate Meeting of the Institution of Chemical Engineers, held at the Hotel Victoria, London, W.C.2, 11th March 1927. Pp. 7. (London.)

The Scientific Proceedings of the Royal Dublin Society. Vol. 18 (N.S.), No. 33: The Maintenance Requirements of Cattle on Different Rations and at Different Rates of Production; with a Note on 'Dynamic Action.' By James Wilson. Pp. 399-406. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 6d.

Annual Report of the Auckland Institute and Museum for 1926–27, adopted at the Annual General Meeting held on 7th March 1927. Pp. 20. (Auckland, N.Z.)

Transactions and Proceedings of the New Zealand Institute. Vol. 57. Pp. x+1123+80 plates. (Wellington, N.Z.)

New Zealand: Dominion Museum. Bulletin No. 8: Games and Pastimes of the Maori; an Account of various Exercises, Games and Pastimes of the Natives of New Zealand, as practised in former Times; including some Information concerning their Vocal and Instrumental Music. By Elsdon Best. Pp. viii+191+67 plates. (Wellington, N.Z.)

The Scottish Forestry Journal: being the Transactions of the Royal Scottish Arboricultural Society. Vol. 41, Part 1, March. Pp. x+104+30. (Edinburgh: Douglas and Foulis.) 3s.

FOREIGN.

Statens Meteorologisk-Hydrografiska Anstalt. Årsbok, 6, 1924. 3: Vattenståndet vid Rikets kuster. Pp. ii+21. (Stockholm.) 2 kr.

Meddelanden från Statens Meteorologisk-Hydrografiska Anstalt. Band 3, No. 10: Sur la structure thermique de l'atmosphère au-dessus de la Suède méridionale; sondages faits par avion en 1924 et 1925. Par F. Lindholm. Pp. 42. 2.50 kr. Band 3, No. 11: De svenska vattendragens arealförhållanden. 4: Piteälv m.fl. Av Gustaf Wersén. Pp. 16. 1.50 kr. Band 3, No. 12: Recording Nocturnal Radiation. By Anders Ångström. Pp. 12. 1 kr. (Stockholm.)

U.S. Department of Agriculture: Weather Bureau. *Monthly Weather Review*, Supplement No. 28: Climatological Data for the Tropical Islands of the Pacific Ocean (Oceania). By W. W. Reed. Pp. iii+22. (Washington, D.C.: Government Printing Office.) 10 cents.

General Guide to the Exhibition Halls of the Peabody Museum of Natural History, Yale University. Prepared by the Curators, edited by Clara M. LeVene. Pp. 54. (New Haven, Conn.) 25 cents.

Astronomical Papers prepared for the Use of the American Ephemeris and Nautical Almanac. Published by the Nautical Almanac Office, U.S. Naval Observatory, by direction of the Secretary of the Navy and under the Authority of Congress. Vol. 9, Part 3: The Orbit of Neptune's Satellite and the Pole of Neptune's Equator. Pp. ii+275-337. (Washington, D.C.: Government Printing Office.)

University of California Publications in American Archaeology and Ethnology. Vol. 22, No. 3: Washo Texts. By Grace Dangberg. Pp. 391-443. (Berkeley, Calif.: University of California Press; London: Cambridge University Press.) 65 cents.

Bulletin of the National Research Council. Vol. 11, Part 3, No. 57: Molecular Spectra in Gases. Report of the Committee on Radiation in Gases. Pp. 358. (Washington, D.C.: National Academy of Sciences.) 4 dollars.

Department of the Interior: Bureau of Education. Education in the United States of America. Prepared under the Direction of Jno. J. Tigert for the Pan Pacific Conference on Education, Rehabilitation, Reclamation and Recreation, Honolulu, T.H., April 11 to 16, 1927. Pp. v+75. (Washington, D.C.: Government Printing Office.) 20 cents.

International Hydrographic Bureau. List of Lifesaving Stations of the World, with their Equipment and Geographical Positions. Liste des Stations de sauvetage du monde entier, avec leur equipement et leurs positions géographiques. By Rear Admiral A. P. Niblack. (Special Publication No. 18.) Pp. 82. (Monaco.) 30 cents.

Conseil Permanent International pour l'Exploration de la Mer. Bulletin statistique des pêches maritimes des pays du nord et de l'ouest de l'Europe. Vol. 14, pour l'année 1924. Pp. 51. Rapports et procès-verbaux des réunions. Vol. 41: Procès-verbaux (Septembre 1926). Pp. 209. (Copenhague: Andr. Fred. Høst et fils.)

CATALOGUE.

Classified List of Second-hand Scientific Instruments. (No. 90.) Pp. vi+56. (London: C. Baker.)

Diary of Societies.

SATURDAY, May 7.

Royal Society of Medicine (Otology Section) (at 1 Wimpole Street, W.), at 9.15 a.m.—Annual General Meeting.

Biochemical Society (in Physiology Department, Manchester University), at 3.—Kathleen Culhane and Dr. G. W. F. Underhill: Variations in the Serum Calcium of Rabbits.—F. C. Happold: The Attempted Isolation of a Type Precipitinogen from *B. aertrycke*, Mutton.—P. W. Clutterbuck: Experiments on the Origin of Succinic Acid in Muscle and Liver.—C. E. M. Pugh and Prof. H. S. Raper: The Action of Tyrosinase on Phenols.—E. Boyland and A. D. Ritchie: Chemical Changes in Muscle.—J. Pryde and J. M. Peterson: The Carbohydrate-phosphate Component of Animal Nucleic Acid.—J. Pryde and E. T. Waters: Some Observations on Methylated Glycerophosphates.—T. K. Walker and P. D. Coppock: Fermentation of Propionic Acid by *Aspergillus niger*.—Ellen Stedman and E. Stedman: Hæmocyanin. Part IV. The Dependence of the Shape of the Oxygen Dissociation Curve on the State of Ionisation of the Protein.

Institution of Municipal and County Engineers (South-Eastern District) (at Grand Hotel, Dover), at 4.—J. A. Jarvis: Notes of the Earlier Housing Schemes of the Corporation.—W. Bryan: Notes on Housing in the Tower Hamlets District of the Borough of Dover.—F. V. How: The Pier District Improvement Scheme, Dover.—W. B. Smith: Dover—Notes on Recent Municipal Activities.

Institute of British Foundrymen (Lancashire Branch) (at College of Technology, Manchester), at 4.—E. Longden: Some Aspects of Foundry Work.

MONDAY, May 9.

Royal Irish Academy, at 4.15.

Royal Society of Edinburgh, at 4.30.—Prof. D. Noel Paton: Submergence and Postural Apnœa (Cessation of Breathing) in the Swan.—Prof. H. G. Cannon: On the Feeding Mechanism of *Nebalia Bipes*.—A. H. R. Goldie: The Structure and Movement of the Atmosphere as affected by Diurnal Variations.—*To be read by title*:—Dr. A. W. Greenwood and Dr. F. A. E. Crew: On the Quantitative Relation of Comb Size and Gonadic Activity in the Fowl.

Royal Institution of Great Britain, at 5.—General Meeting.

Aristotelian Society (at University of London Club), at 8.—Miss Hilda D. Oakeley: The World as Memory and as History.

Royal Society of Arts, at 8.—J. W. T. Walsh: The Measurement of Light (Cantor Lectures) (3).

British Psychological Society (Education Section) (at London Day Training College), at 8.—Mrs. Susan Isaacs: The Function of the School for the Young Child.

Surveyors' Institution, at 8.—A. M. Trustram Eve and others: General Discussion on The Practical Application of the Rating and Valuation Act, 1925.

Institution of Electrical Engineers (Western Centre) (at Plymouth).

TUESDAY, May 10.

Royal Society of Medicine (Therapeutics and Pharmacology Section) at 5.—Annual General Meeting.

Institution of Petroleum Technologists (at Royal Society of Arts), at 5.30.

Zoological Society of London, at 5.30.—Dr. R. Broom: On Sphenosuchus, and the Origin of the Crocodiles.—Dr. H. H. Scott: (*a*) Neoplasm in an Indian Rhinoceros; (*b*) Two Cases of Peritoneal Neoplasm (Endothelioma).—C. A. Hoare: Schewiakoff's Keys for the Determination of the Holotrichous Ciliates.—Dr. F. P. Stowell: The Resistance of certain Metals and Metallic Alloys to Corrosion and Solution by Sea-water.

Institution of Civil Engineers, at 6.—Annual General Meeting.

Institute of Marine Engineers, at 6.30.—H. J. Young: Some Metals and Methods of Use in Marine Engineering.

Royal Photographic Society of Great Britain (Kinematograph Group), at 7.—A. S. Newman: Inertia Momentum.—A. J. Griffin: The Care of Kiné Negative during Development.

Quekett Microscopical Club, at 7.30.—Dr. D. Ward Cutler: The Effect of External Conditions on Soil Micro-organisms.

WEDNESDAY, May 11.

Electrical Association for Women (Annual Meeting) (at Hotel Cecil), at 11.30.—At 3.30 (at Magnet House, Kingsway).—Lecture on Refrigeration and the Pure Food Act.

Royal Society of Medicine (Surgery: Sub-Section of Proctolog (Annual General Meeting), at 5.—W. E. Miles, W. B. Gabriel, a others: Discussion on Colostomy.

Geological Society of London, at 5.30.—Prof. P. G. H. Boswell: T Salopian Rocks and Tectonics of the District South-West of Ruth (Denbighshire).—R. C. Blackie: The Geology of the Country betwee Llanelidan and Bryneglwys.

Royal Society of Arts, at 8.—Prof. W. E. Dalby: English Railwa (Dr. Mann Lectures) (2).

Institute of Metals (at Institution of Mechanical Engineers), at 8.—Sir Henry A. Miers: The Growth of Crystals in Supersaturate Liquids (Annual May Lecture).

Eugenics Society (at Royal Society), at 8.30.—Miss Evelyn Lawrence Intelligence of Institution Children.

THURSDAY, May 12.

Royal Society, at 4.—Election of Fellows.—At 4.30.—Discussion o The Function and Distribution in Living Organisms of Hæmoglob and Related Substances. Speakers: Prof. J. Barcroft, Dr. H. Har ridge, Sir Frederick Hopkins, Dr. D. Keilin, F. J. W. Roughto R. Hill, Prof. H. M. Fox, Dr. J. B. S. Haldane.

London Mathematical Society (at Royal Astronomical Society), at 5.—Prof. H. F. Baker: Geometry and Differential Geometry (Lecture).

British Science Guild (Annual Dinner) (at Criterion Restaurant), a 7.30.—Speakers: Sir Alfred Mond, Bart., Sir Herbert Samuel, Gen. S George F. Milne, Hon. W. Ormsby-Gore, Sir William Pope, S Frederick Keeble, Rev. Prebendary Gough.

Optical Society (at Imperial College of Science and Technology), a 7.30.—Prof. M. von Rohr: Note on the History of English Optician in the First Half of the Nineteenth Century (with special reference t Spectacle History).

Institution of Structural Engineers (at 10 Upper Belgrave Street S.W.), at 8.—A. G. Pugsley: Some Problems in the Design of Ste Roof Truss Members.

Oil and Colour Chemists' Association (Annual General Meeting) (a 8 St. Martin's Place, W.C.), at 8.—A. de Waele: Some Physica Factors influencing Properties of Paint Pigments.

FRIDAY, May 13.

Association of Economic Biologists (at Imperial College of Science an Technology), at 2.30.—Plant Alkaloids:—Lieut.-Col. A. T. Gage: Th Principal Plants yielding Alkaloids.—Dr. T. A. Henry: The Bio chemistry of the Alkaloids.—Dr. J. Trevan: The Medical Aspects o the Alkaloids.

Royal Astronomical Society, at 5.

Malacological Society of London (at Linnean Society), at 6.

Junior Institution of Engineers, at 7.30.—Dr. H. Chatley: Th Stability of Dredged Cuts in Alluvium.

Royal Institution of Great Britain, at 9.—Sir Humphry Rolleston, Bart.: Concerning Old Age.

SATURDAY, May 14.

Royal Society of Medicine (Balneology and Climatology Section (Annual Provincial Meeting) (at Llandrindod Wells).

SUNDAY, May 15.

Royal Society of Medicine (Balneology and Climatology Sectio (Annual Provincial Meeting) (at Llandrindod Wells).

PUBLIC LECTURES.

SATURDAY, May 7.

Oxford University, at 12.—Sir John Simon: The Labrador Boundary.

SUNDAY, May 8.

Guildhouse (Eccleston Square, S.W.), at 3.30.—Ancient Civilisations.

TUESDAY, May 10.

King's College, at 5.30.—Prof. A. Michotte: Problems of Mental Work. (Succeeding Lectures on May 12 and 13.)

Royal School of Mines, at 5.30.—Dr. F. F. Blackman: Problems o the Respiration of Plants. (Succeeding Lectures on May 17 and 24.)

University College, at 5.30.—W. H. McLean: National, Regional and Town Development Planning. (Succeeding Lectures on May 17, 24, and 31.)

Gresham College (Basinghall Street, E.C.), at 6.—A. R. Hinks Astronomy. (Succeeding Lectures on May 11, 12, and 13.)

THURSDAY, May 12.

University of Birmingham (Faculty of Medicine), at 4.—Dr. F. A. E Crew: Organic Inheritance in Man (William Withering Memoria Lectures). (Succeeding Lectures on May 19, 25, 26, June 1 and 2.)

Institute of Pathology and Research, St. Mary's Hospital, at 5.—Dr. R. A. O'Brien: Streptococci—their Toxins and Antitoxins.

FRIDAY, May 13.

University College, at 5.30.—Prof. J. Burnet: Platonomic Problems. (Succeeding Lectures on May 20 and 27.)—At 8.30.—Sir John Rose Bradford: University College, London, and Medical Educatio (Centenary Celebrations Address).

SUNDAY, May 15.

Guildhouse (Eccleston Square, S.W.), at 3.30.—Dr. D. G. Hogarth: Th Hittite People and their Civilisation.

CONVENTION.

June 6 to 9.

Convention of Canadian Chemists (at Quebec).

SATURDAY, MAY 14, 1927.

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British Settlement in the Dominions Overseas.

THE various schemes which were formulated just before the War to alleviate the hardships of the indigent workless and destitute and to provide for their old age had an immediate retarding effect upon emigration from the United Kingdom. The majority of emigrants are manual workers, and anything which makes for their greater security in Great Britain must increase their natural reluctance to become the sport of chance circumstance in other lands. But the empty spaces of our vast dominions must be peopled, and it is held that it is best they should be peopled by our own stock. With this object in view the Empire Settlement Act was placed on the Statute Book in 1922, to enable the Home Government, in association with the government of any part of His Majesty's Dominions, or with public authorities or public or private organisations, to formulate and co-operate in schemes for development or land settlement, and for facilitating settlement in or migration to our dominions by assistance with passages, initial allowances, training, or otherwise.

The Committee appointed to carry out these schemes has just presented to Parliament a report for 1926.[1] The total number of persons assisted under the Empire Settlement Act increased from 39,559 in 1925 to 66,103 in 1926, or rather more than two-thirds of the total number of emigrants to the Dominions and more than half the net movement of population from Great Britain. The numbers assisted to Australia and New Zealand show increases of 10,205 and 3698; while the numbers assisted to Canada have risen from 8809 in 1925 to 21,344 in 1926. The Committee states that out of a net movement from Great Britain in 1926 of 115,538 persons, 93,227 went to homes within the Empire, a gratifying proportion. If this number of emigrants is maintained for the next few years, the average will be considerably above that for the decade 1901 to 1911, when it averaged 76,000 persons a year. Yet, as the Committee points out, the net movement from Great Britain overseas represents only two-fifths of the natural increase in our home population. If it is a fact, therefore, that Great Britain is already overcrowded, and, as many think, that under our present system we cannot keep all our people who are willing to work employed, the need for a greatly accelerated movement of our home population overseas is a matter of supreme urgency.

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[1] Report of the Oversea Settlement Committee for the Year ended 31st December 1926. (Cmd. 2847.) Pp. 30. (London: H.M. Stationery Office, 1927.) 6d. net.

It is interesting to find that Australia absorbs more than half the migrants within the Empire. It seems reasonable that Australia should be preferred to Canada, but it is a little difficult to understand why New Zealand does not attract more settlers: it is a lovely and varied land, with a delightful climate and abundant natural resources. The Committee offers no explanation; neither are we informed in the report why so few British migrate to South Africa: only 126 went there in 1925 and 232 in 1926. The great increase in the number migrating to Canada is to be explained by the liberal arrangements made for their reception and settlement, including what appear to be generous terms for capital advances.

The subject of migration is important enough to warrant a much more comprehensive account of the work of the Oversea Settlement Committee than that which has been vouchsafed in this report. But the subject is dismissed in 16 pages, most of which are filled by rather vague generalisations, interspersed with quotations from other Government publications. Most of the vital statistics contained in the report are given above. A little information, it is true, is to be found in the four appendices which fill the last 11 pages of the report. Yet many aspects of the problem upon which it might be assumed members of Parliament would wish to be informed are not dealt with at all. No reference is made as to the proportion of British to other European immigrants to the Dominions, or to the assistance given by other nations to their emigrants. The tide of emigration from central and southern European States, in many of which the standard of living of the working classes is appallingly low, has an important bearing upon the overseas settlement of our own people. No attempt is made to deal with the economics of migration. If information is desired on this aspect of the subject, it must be culled from the biased and often unsubstantiated statements of overseas statesmen, or from the handbooks issued by the various shipping agencies, any of which, it must be confessed, are more informative than this official report. Yet there is much information to be gathered from an examination of our trade returns. Each family settled in Australia, for example, creates a demand for our home products the value of which is roughly equivalent to the amount required to maintain a family at home. If satisfactory arrangements could be made to transfer 20,000 families yearly to Australia, our own unemployment proble would be quickly solved.

There are other omissions. No information given regarding the relative suitability of th various parts of the Dominions for settlement, what are the principal crops raised or the market they serve. Nothing is said regarding the term on which land is granted: prospective emigrant will look in vain for information regarding the pr vision of the amenities of life to which they ar accustomed at home, for example, education an health services, housing, transport, and communic tions. No indication is given of the return whic can be expected from arable or mixed farmin or what are the prospects for pastoralists, base upon the purchase price of available land, the co of domestic stock, and the cost of living.

The most serious omission, however, is in co nexion with the movement of the rural popul tions of the Dominions towards the towns. It well known that the urban populations of th Dominions are increasing far more rapidly than th rural populations. The percentage increase the urban population of Australia in the decad 1911–1921 was approximately 36, whereas th increase of the rural population in the same perio was less than 9 per cent. It is a striking fact tha the ratio of "primary producers" to other classe in Australia—an agricultural country—is apprec ably smaller than the corresponding ratio for Grea Britain—a highly industrialised community. is sometimes urged that our education system i Great Britain is at fault for failing to make rur life more attractive than life in our large cities and the criticism is just. With equal justice i could be urged that Australia has not yet come t grips with the same problem. The Australia town-dwellers realise their success mainly depend upon a growing number of agriculturists, and the are prepared to support any scheme which wi attract agricultural settlers from Great Britai just as ardently as they will oppose the indi criminate transference of our urban populatio to their towns; but they fail to realise, apparentl that the flight from the land can be retarded o arrested only by complete re-orientation of thei education system coupled with profound modifica tions of their economic policy.

It would be interesting to know from whic classes of the home community overseas settle are drawn, and it should not be difficult to includ such an analysis in a report of this kind. In th summary of Lord Clarendon's report on his visi to Canada, it is stated: "Possibly somewhat to trong a preference may have been shown for amilies with farm experience. Inexperienced amilies, if they have the right spirit, seem to ucceed just as well as the experienced. . . . amilies from the coal-mining districts of Great Britain appear to show as good an average of uccess as any other families settled under the cheme." An authoritative statement of this ind is of the utmost importance, but it would arry even greater weight if it were backed up y statistical evidence. Even such a qualitative tatement, however, should do much to break own the prejudice of selection committees against ffering inducements to urban workers to settle n the land in our Dominions. What the urban worker lacks in experience in comparison with he farm-worker is offset by his greater adaptability o new conditions, an adaptability born of a higher ntellectual standard. Rural education in Great Britain is still in a backwater.

The Committee states that it is "conscious of he closeness of the relationship between research, development, and settlement." It would be interesting to know what kind of research the Committee has in view, what are the problems which ace the Dominions for which no solution can be ound on the basis of knowledge already available. Unquestionably there are vast fields of inquiry n which research workers may labour. But the Saul-like conversion of our imperial statesmen to he new faith in scientific research must not blind hem, any more than the members of the Oversea Settlement Committee, to the fact that settlement and development schemes can be based upon existing knowledge. The immediate need is for a comprehensive survey of the accessible and potential resources of the Empire, an Empire stocktaking, in fact, upon which all sound schemes of overseas settlement and research should be based.

It is to be hoped that in its next report the Committee will make a real attempt to deal with the problem of re-distribution of population in a scientific spirit. There are a number of diverse contributory factors to be taken into account in an inquiry of this nature, most of which appear to have been completely ignored hitherto. The report, in fact, constitutes a slight on the members of Parliament to whom it is made. It implies either that they do not possess the intelligence to examine the problem of migration of peoples thoroughly, or that they have very little interest in a subject of vital importance to the whole of the advanced peoples of the world.

The Numerical Measurement of Genius.

Genetic Studies of Genius. Edited by Lewis M. Terman. Vol. 1: *Mental and Physical Traits of a Thousand Gifted Children.* By Lewis M. Terman and others. Second edition. Pp. xiii + 648. Vol. 2: *The Early Mental Traits of Three Hundred Geniuses.* By Catherine Morris Cox, assisted by Lela O. Gillan, Ruth Haines Livesay, and Lewis M. Terman. Pp. xxiii + 842. (Stanford University, Cal.: Stanford University Press; London, Calcutta and Sydney: George G. Harrap and Co., Ltd., 1926.) 21*s.* net each vol.

IT is only when one studies a vast American work like this—which in its first two volumes covers more than 1500 pages, with still more volumes to come—that one realises that America is not Europe, that American science, for good or bad, is obtaining an individuality of its own, and that there is some hope that a population, which anthropologically is probably the most mixed the world has ever experienced, will shake down and ultimately develop national mental, if not national physical, characteristics. America has had many difficulties to contend with; it is not usually the ablest races who emigrate, still less is it the ablest members of those races. For early emigrants also, good physique rather than strong mentality is the essential factor of success. Occasionally, as in the case of Dutch and Huguenot immigrants to England, some political or religious movement drives a better class of men to change their homeland. But the bulk of men who have colonised America, especially of recent years, are men who were not succeeding very well in Europe, and hoped to find in spacious America more room for a return for their hard labour. The very spaciousness of America has been one of its disadvantages. It was possible to *acquire* with relatively little effort; there was no need to preserve or to maintain past acquirements, whether mental or physical; property and tradition were of smaller value than in older and more crowded countries. There was no natural selection of physique or ability, because inferiority had merely to go farther westward, where ease of acquirement increased with every degree of longitude. The alternation from pauper to millionaire was as rapid as the reverse process, for to acquire was so simple that few learnt to conserve.

To most of us who think anthropologically, there is small wonder that America thus far has not been prolific in genius. In Vol. 2 of the work under discussion we find sixteen American men of genius enumerated. Six were presidents (Grant, Jackson, the two Adamses, Lincoln, and Washington), two men of the sword (Farragut and Sherman), four statesmen (Franklin, Hamilton, Seward, and Webster), and four authors (Longfellow, Washington Irving, Emerson, and Prescott), all dying in the century 1790–1890, and all known to every educated European. But would a Frenchman or a German have included more than two or three of these in a list comprising Galilei, Newton, Laplace, Darwin, Shakespeare, Goethe, Molière, Voltaire, Rousseau, Heine, Byron, Spinoza, Descartes, Dürer, Raphael, Titian, Mozart, Bach, *et hoc genus*? These are men of creative imagination, world-shakers, who have set their seals upon human culture, and if only 282 men of genius are to be taken for the four centuries 1450–1850, a sense of proportion might have hindered a European scientific writer from allotting 16 to America in one century!

The Americans are a young people; it will not be possible to call them racially a nation until far more intermarriage has taken place among their component groups, and more intense selection has been called into play; then will come national individuality, and then no doubt also new and typical forms of genius. Were a genius to arise to-morrow in America, whatever his class, one to be reckoned respectively with the six greatest scientific workers, scholars, painters, or authors of the world, he would be an offspring of the Old World, a German, an Englishman, or a Jew, not only racially, but also in modes of thought. Yet the day will indeed come, if not yet, when the typical American genius will appear. Can it be hastened by such a work as we have now notice?

The scheme attempted is undoubtedly a great one, one that could only be imagined by a youthful people without the heritage—or shall we say bondage?—of formed traditions. It proposes first to determine how much in the genius of the past is due to (*a*) heredity, (*b*) native endowment, and (*c*) training; then to discover the gifted children in the American population, and give them the training appropriate to genius. One of the striking points in this novel scheme is that the authors venture to preach in a great democracy the doctrine of caste, that ability runs in families, that not only are gifted children born from superior parents, but also that those parents have superior traditional culture and follow higher-class occupations.

Before we can determine, however, what the 'gifted child' signifies to American psychologist we must appreciate how he is to be selected. One the difficulties of examinational selection of ment characters lies in the differentiation of acquir knowledge from mental facility or general intel gence. The former is partly a matter of age a partly a matter of home environment. To su mount the age difficulty the Binet-Simon tes were devised; they provided a system of tes suited to the average child of each year of lif but even with these it is difficult to ensure th success in passing may not be correlated wit home training. The year-tests which a child cou just answer gave its mental age, and, on th suggestion of Wilhelm Stern, the ratio of ment age to chronological age provided a measure intelligence which might be taken as independen of age. This so-called 'intelligence quotient' h been developed—especially in America—in a immense variety of ways. The original Binet Simon mental age tests have been altered, adapted varied until almost every American university, i not every psychological teacher therein, has a individual series of tests. At the present moment from west to east, from north to south, the America population is being psychologically tested. Universities, schools of all classes, prisons, reformatories, homes for the mentally defective and fo fallen women, orphanages and training camps ar being examined for their intelligence quotients The climax was reached in the War, when the whol American Army was psychologically tested. It average mental age was, if we recollect rightly, jus fifteen years! What is quite certain is tha English public schoolboys and English undergraduates would only treat as a joke the question put to their American confrères to test not onl their intelligence but also their interests, their mora and their religious senses, their sociability and thei personality traits. If we are to trust the mass o papers resulting from these tests, the schedule scatterer must have an easier time in new America than he would have in the Old World!

However, starting with a teacher's selection, followed by a Stanford-Binet psychological test, some 600 boys and girls have been selected out of some quarter of a million of the Californian school children. These are the 'gifted' children from whom we are to expect genius. They and their parents have then been examined in almost every conceivable manner after selection. Their parents have been requested to fill in 'blanks' not only with regard to their children but also with regard to themselves. Anthropometric examinations, medical examinations, 'interests' examinations, character and personality traits examinations, etc., ave been organised to an astonishing degree. We know now whether a Californian gifted boy likes o collect insects or tram tickets, whether he would ike to be a statesman or a Christian Science healer, whether he always remembers to clean his teeth, whether he ever dreams of people being dead, whether he can keep still on being tickled; these re a few among some 85 similar questions!

But we feel some hesitation even yet. Is not real genius inert to all examinations, even to a psychological one? May not the one real genius that California may very likely produce in the next half-century have slipt through the meshes of this intelligence quotient net? Unfortunately, there s no adequate control series being followed up through life in the same way, and if another 600 not gifted, but mediocre, children were being pursued in like manner, would an isolated genius in *one or other series prove anything at all*? We hould be able possibly to judge whether the gifted hildren had or had not done better in life, but the fact that one had taken a Ph.D. degree and become in academic instructor, that another had completed his work for an Sc.D. degree or gone to Europe for study, might only be the effect of the home environment *selected by the sort of questions set in the intelligence test*. Statistically also, when we divide nto sexes, and allow for deaths before achievement, and for the probable disappearance otherwise of nany individuals, the numbers, we fear, may ultimately be found quite inadequate.

As for the statistical treatment of the data, it can only be said to be moderately satisfactory. For example, Dr. Lenz's criticisms on the original German treatment of the size of family in the case of families with gifted children are taken as truth without apparently any further examination; but n the case of a family of eight or ten children whose births may be extended over a period of ourteen or sixteen years, it is not equally probable that all the children will be found at school at the same time, and Lenz's method of correcting fertility is fallacious, and therefore Terman's conclusions drawn by applying it appear to be incorrect. Again, in the fundamental table on p. 41 and in the "corrected" table, p. 44, no comment is made on the large correlation of intelligence quotient with age (correlation ratio of quotient on age is of the order 0·37), and yet this is certainly a matter which deserved ample treatment. The method of correction detailed in a footnote is, we venture to think, obscure, and the diagrams are not adequately elucidated. Many other points will occur to the mathematically trained statistician on reading the work.

Still, we would not appear ungrateful for the labour which the collection of such an immense amount of data—of varying grades of usefulness—must have involved. In the course of the next thirty or forty years we may know whether the grading of children by aid of their intelligence quotients is correlated with their success in after life. That may not be without value and scientific interest, but we may reasonably ask whether it could not have been better accomplished by following up an *additional* 600 children with low intelligence quotients rather than by piling up *questionnaires* on the first group. That we are, by the study of these high intelligence quotient children, on the path to determine anything about the genetics of or the suitable training for 'genius,' frankly, we do not believe.

We *might* think that the word '*genius*' is understood in a different sense in Europe and in America, but when we turn to the second volume of these "Genetic Studies of Genius," we find that in the abstracts of the "Early Mental Traits of Geniuses" (which occupy some 600 out of the 800 pages of this volume), the bulk of the individuals included are those that a European would classify in the same way. Yet if 'genius' be one in a million—are there indeed 10 male geniuses in England at this moment?—what hope is there of those 352 'gifted' Californian children throwing light on the matter? However, Miss Catherine Cox accepts the European estimate, if with some patriotic bias. How, then, are these accounts of the early intelligence and early environment of genius to be brought into relation with the gifted children of California? Only if we can assign by the accounts we have of the childhood of genius —*i.e.* on the basis of biographies—the corresponding intelligence quotients!

Now the great merit of the Binet-Simon tests arises from the fact that they give a numerical value to the living child by aid of direct experiments. It appears to the present reviewer that when the psychologist turns the matter inside out and says that he has had such experience of these tests and of young children that he can measure the childish 'brilliancy' of genius as reported in dictionaries of biography by means of allotting intelligence quotients, he is standing as a scientific worker on a very dangerous slope indeed. Here again we have no control series, which would have to be from as many nations as the men of genius are selected from. Yet without such a series, how can we judge the precocity, the 'brilliancy' as our author terms it, of these nationals ? In the case of great men, every scrap of their handwriting has been sought for and often preserved ; in the case of mediocre men, it goes into the waste-paper basket when their mothers die. Erasmus is given an intelligence quotient of only 135 before seventeen years age. What would it have been had his school scribblings been preserved ? Benjamin Franklin is given one of 145, because we have his autobiography and know of his childhood. James Stuart Mill is given an intelligence quotient of 200, not because he was ever natively brilliant, but because his apt intelligence was reared in a forcing house by James Mill ; and how old-fashioned would now be the economist who would even admit James Stuart Mill to a place among the 282 men of genius of four centuries in Europe ! Galton as a child is given an intelligent quotient of 200, because his biographer included certain letters from his childhood in his Life ; Darwin as a child is given an intelligence quotient of only 135, because his biographer had not, or did not think fit to print, any such letters. Newton as a child is measured by 130, but Leibnitz as a child by 185. Shakespeare cannot be rated at all, because nothing of his childhood has been preserved for us. What would such ratings be worth if they were not, as they actually are, guesses ? They depend entirely on the amount and character of the material which has been preserved for forming an estimate ; they depend on the nation to which the man of genius belonged. They can tell us nothing of the extent to which relative achievement in later life depends upon relative childish 'brilliancy.' With Defoe, Linnæus, Napier, Harvey, and John Locke as children at 125, and Klopstock, Wieland, and Longfellow at about 150, what can we learn from this modern psychological guessing based on biographical dictionaries ?

Our author prefaces her work with much talk about the value and accuracy of 'historiometric' methods of investigation; she gives various mathematical investigations of the exactness of the process of guess-work involved and of her methods of 'correcting' her numerical estimates. Some of this is very open to question from the mathematical side. We do not base our main criticism on that, but on these two indubitable facts : first, that she has no control series of the mediocre men of the various nations through these centuries, and secondly, that the estimates of her colleagues and herself, even if accurate, depend entirely on the amount of data known, or at least cited in th biographical dictionaries. How would the intelligence quotient of Newton as a boy be modified b the discovery of his diary, or the knowledge that hi mother sprung from an illustrious family? Ho would Nelson's 125 as a child be modified had th writer known that his mother was descended fro the Walpoles, one of the English families most noteworthy for administrative ability ?

Do we consider then that this volume is a wast product of several years' work ? Not in the least We know no book that so satisfactorily condense the main facts with regard to the boyhood of grea men. Its usefulness will survive long after th intelligence quotients which are scattered throug its pages have ceased to be regarded. Is this th judgment of a European ? Very possibly. Th fact that it becomes more and more difficult for th European to grasp and judge modern America scientific work may be rather evidence of th European's conservatism than of the naïveté o that work itself. America is not, but is becoming a nation, and, as we all know, nations with th very best intentions fail to understand each other Youth too often fails to interpret itself to age.

Chinese Agriculture.

Die chinesische Landwirtschaft. Von Dr. Wilhelm Wagner. Pp. xv + 668. (Berlin : Paul Parey 1926.) 42 gold marks.

THE agricultural methods of China have lon excited the interest and curiosity of Wester experts, partly because they are highly intensiv and partly because of the element of mystery stil surrounding all things Chinese. On wester methods, 2-2¼ acres of land are required for th maintenance of each person ; but there are grea areas in China where two acres of land support n less than five people, to say nothing of a donkey an other animals. The comparison is striking, eve allowing for the great difference between easter and western ideas of maintenance.

Hitherto, and in spite of its inherent interest Western experts have had little opportunity o learning anything about Chinese agriculture There are a few articles in the Chinese Repository and in Millard's "Review of the Far East," no usually available in agricultural libraries, but n account by any English writers except the usefu summary in the "Encyclopædia Britannica." The only accessible account hitherto has been tha written by the late F. H. King, the well-know il physicist of Wisconsin, who visited the Far ast in 1910 and recorded his impressions in his ook, "Farmers of Forty Centuries."

Dr. Wagner had therefore almost a clear field hen he undertook to describe Chinese agrilture. His qualifications for the task are conlerable; he was appointed as agricultural cturer in 1911 to the High School set up by the ermans in Tsingtau for the education of the hinese, and he remained in China until 1920. hen he began, the school was only two years old, nd the agricultural equipment, he tells us, was a ackboard, a sponge, and a piece of chalk; by ugust 1914, laboratories had been erected and the stitution possessed 16 hectares of experimental rm land and proper farm buildings, with more han 30 head of cows and 5 horses in addition to gs and other animals. His students came from arious parts of China, and he had many opportunities of learning about its agriculture.

The plan is to discuss first of all the natural onditions, particularly climate and soil, then the uman factors, finally the methods of dealing ith the soil and its chief crops.

The author adopts the usual divisions of China to a northern and a southern section separated y a folded range of the Tsing-ling-shan. The orthern part is subdivided into the western ghlands, often desert and sparsely populated; nd the eastern plain of yellow loess soil, entirely gricultural and densely populated. The south somewhat similarly divided, but the soil is not ess; it is largely sandy or calcareous. Again, owever, the east is the agricultural land with the ense population. The river valleys are highly rtile, but even the hills are cultivated, being laid p in terraces.

The agricultural interest lies in the eastern ortions of the country; it is there where the ntensive methods are used. The basis of the crop roduction is a close regulation of the water supply o the crop necessities. China has a network of anals which serve to drain land that has too much ater, to irrigate land that has too little, and also s a means of transport and communication, the oads being bad. The rainfall is high; so far as he slender records go, it varies from 25 inches in he Shantung peninsula to 100 inches or more in he warmer sub-tropical parts; it is more variable n the north than in the south. Much of the lower and is drained, but almost always by open drains, ccasionally in the south by bamboo pipes, but ever, so the author tells us, by clay pipes. rainage is, however, less important than might appear, because the rainfall comes mainly in the summer, and swamp land is not the waste in China that it is in colder climates, for the paddy rice flourishes in it. The problem is rather the other way; land otherwise dry is watered so as to obtain maximum yields. This circumstance that the highest rainfall of the year comes in summer is an important factor in determining the intensiveness of Chinese agriculture. Crops have water during warm weather when they need it, and they are not hampered by high rainfall in winter when they do not need it. Where the winter is not too cold, two crops a year become possible; they are obtained on much of the land in the centre and south (though not usually in the north), especially on the tropical rice land which lies high enough to be dry in winter and yet can if necessary be flooded in summer. Even the low-lying wet land can be made to carry two crops.

The descriptions of the agricultural implements suggest affinities with Babylon and ancient Egypt rather than with Bronze Age north Europe, and it would be interesting to make a careful comparison between the agricultural system of ancient China and that of ancient Egypt so far as this is known or can be inferred from later Arabic writings. Some of the implements, however, notably the harrow and the roller, have a very western appearance.

Among the commonest manures are the mud from canal bottoms, green material cut from the large areas devoted to graves, and, above all, human excrements, all of which are carefully collected and applied to the land.

The chief food crops are rice and millet, and they form a good combination, since rice can tolerate any amount of water and millet does well in dry conditions, having great power of withstanding drought, and at the same time growing well when rain comes. The second crop, grown in winter, may be wheat, barley, beans, pease, or various vegetables. Land not well suited to rice, by reason of being too high above the water level of the canal, is devoted to bamboos, mulberries, fruit and vegetables.

This section of the book would have been more interesting had the author had more of his own photographs. As it is, he is driven to use illustrations from King's book of 1911. He devotes a great part of his book to descriptions of the crops, their varieties, and the conditions in which they are grown. The number of crops is amazing; including all the grain crops, many oil seeds, strange plants such as the lacquer tree (*Rhus vernicifera*) and the tallow tree (*Sapium sebiferum*), in addition to the better known tea, cotton—said to have been introduced into China from Khotan in the eleventh century—mulberry trees and other crops traditionally associated with the country. The animals are described at length, and finally the author collects some materials for a summary of the economic position of the Chinese farmer, an interesting attempt which one would like to see followed up.

As the only recent book on the subject, the volume would in any event be of interest to the agricultural expert. Added to this are its intrinsic merits; the mass of information, numerous illustrations by photographs and diagrams, and, where they can be obtained, figures of yields or analytical data. To those interested in eastern agriculture it will prove very valuable.

E. J. RUSSELL.

The Textile Industry.

Textile Bleaching, Dyeing, Printing and Finishing Machinery. By A. J. Hall. Pp. 320. (London: Ernest Benn, Ltd., 1926.) 50*s*. net.

THIS book is a very welcome addition to the literature of British textile industries. It brings together, in a complete form, a comprehensive summary of the best modern methods of carrying out the several important processes stated in the title of the book. Hitherto these processes have only received a cursory treatment and then simply as separate subjects. The author is to be congratulated on the able manner in which he has filled the gap in our technical literature and given an unusually complete survey of the mechanical methods used in carrying out the various processes.

The almost complete elimination of any idea of secret methods in spinning and weaving has been brought about by the publication of text-books, and the establishment of technical schools and research institutions. In the same manner progress can only be attained and maintained by clear statements of the best and most efficient methods of carrying out the processes of bleaching, dyeing, printing and finishing. The empirical methods of yesterday are totally inadequate to meet the world-wide competition of to-day, and they have always been a bar to development and progress. This book will place in the hands of the chemist, the engineer, the bleacher, dyer, and finisher a mass of information that will enable them to build up a solid business on sound constructive principles. Since each process is both important and extensive, the book is necessarily large, and although it h been compiled under only nine chapters, t illustrations number 365, excellently reproduced half-tone and line blocks.

The arrangement of the matter has not been l any means an easy task owing to the close inte dependence of many of the processes, but th author has solved the difficulty in a fairly sati factory manner. He deals with the machinery various types used in each process, and whil avoiding the display of preference for any pa ticular machine, has the happy knack of expressing himself that the reader can readi understand what machine will be best for a particular purpose. The book therefore becom an invaluable work of reference, and is ve suggestive, to a progressive man, in conveyi ideas of further improvements.

Whilst machinery forms the staple matter the book, each set of machines has an introducto explanation as to the necessity of the machine so that the non-technical reader can readily unde stand the various steps carried out in any giv process. A very wide field of textiles is covere and whilst the chief aim is intended to be of re practical utility to the trade, the work may pro of great value and interest to many people who d not share in the actual production of texti materials, but are vital factors in dealing with t fabrics and materials after they are finishe including merchants, drapers, etc., and, even many of our bleaching and dyeing works, th directors who have seriously to consider t question of equipment. All interested in th great industry will find the book of immense valu and we congratulate the author on what must ha been a severe task. The book is well bound, i type is clear, and it bears evidence of the utmo care having been taken in its preparation.

W. S.-T.

Our Bookshelf.

How Natives Think (*Les fonctions mentales dans l sociétés inférieures*). By Prof. Lucien Lév Bruhl. Authorised translation by Lilian S. Clar Pp. 392. (London: George Allen and Unwi Ltd., 1926.) 12*s*. 6*d*. net.

IN his preface to this book the author explai that "La Mentalité primitive," which appeared English in 1923, and "Les Fonctions mentales da les sociétés inférieures," of which this is a transl tion, are two volumes of one work. By an accide of circumstances, the second volume was tran lated into English before the first. This w unfortunate, as the essential principles of M. Lév ruhl's theories are contained in the latter, and though the two books can be read apart, some owledge of these principles is necessary before e argument can be grasped as a whole.

M. Lévy-Bruhl's thesis is, in the main, a con-ructive criticism of the views of the English hool of anthropologists at the head of which and Tylor and Frazer. He holds that the work this school is based upon an assumption that e working of the human mind is everywhere and all cases identical. The vast body of facts lating to primitive peoples which have been thered together in the employment of the com-arative method, have been interpreted in the ght of the animistic theory and explained by the w of association, whereas the author maintains ey can only be understood as 'collective repre-ntations'—social phenomena having their own ws which no analysis of the individual *qua* dividual, such as is implied in the method of e English school, can ever reveal. The 'dif-rence in degree' in savage mentality which recognised by the English school, therefore, ecomes for M. Lévy-Bruhl a difference in kind.

Thanks in a great degree to the French school of ociologists and social anthropologists, and to the ork of certain anthropologists in England, the endency to consider facts entirely *in vacuo* is now y no means so marked as it has been. M. Lévy-ruhl's stimulating book, in which the conse-uences of the difference of point of view are orked out in detail, is by no means so entirely estructive of English theory as he hopes, but it ill serve as a caution and a corrective.

ight Treatment in Surgery. By Dr. O. Bernhard. Pp. xii + 317. (London: Edward Arnold and Co., 1926.) 21*s.* net.

N a foreword to this book, Prof. Leonard Hill efers to it as a masterly production, and we are nclined to agree with this verdict. The translator as done his work exceedingly well, and we now ave a book to which we can turn with some onfidence on the question of the use of light reatment in surgery; we hope that some one will e found who can cope with light treatment in edicine in as broad a comprehensive way as the uthor of the work under notice. We shall then e spared a continuance of the present holocaust f books written on the subject of ultra-violet therapy by writers of very little experience.

The book is divided into two parts, the first being general in its scope, the second, special in the sense that it deals with the actual light treatment in surgical cases. The two parts of the book are of about equal length, and the first five chapters give one a very good idea of our present state of knowledge on the effect of light on the organism generally, right up through the vegetable and animal kingdoms.

The second part of the book is divided into a section dealing with the indications for the use of this therapy and two sections on the helio-therapy of surgical tuberculosis. Scattered throughout the book are photographs and radiographs illustrating the good effects which often accompany the treatment of patients with sunlight. That climatic conditions play an important part in the treatment of tuberculous patients is recognised by the author, and, in fact, twenty-five pages are devoted to this subject. In a book the object of which has been to set forth the beneficent action of sunlight in disease, a section of no less than twenty pages is devoted to the pathological action of sunlight. The dangers to specially sensitive subjects and those accompanying over-doses of radiation are dealt with very fully.

The book should be welcomed by those who have looked, so far in vain, for an authoritative account in English of this new, yet really very old, form of therapy.

S. R.

An Outline of Plant Geography. By D. H. Campbell. Pp. x + 392 + 52 plates. (New York: The Macmillan Co., 1926.) 17*s.* net.

Dr. D. H. Campbell has written a simple and highly interesting outline of plant geography which can be read with pleasure and profit by the botanist, and also, which is of more importance, by all who are interested in the vegetation of the earth. He reviews in a light and pleasant manner the types of vegetation to be found in the north temperate zones of the old and new world, paying special attention to the interesting floral region of the western States of America and British Columbia. The south temperate zone is similarly discussed, and the central portion of the book is occupied with a description of the palæo- and neo-tropical regions, and their dense tropical forests. The descriptions of vegetation and scenery are enhanced throughout by numerous good and characteristic pictures, which add greatly to the interest of the book to the more general reader. Two prefatory chapters dealing with the succession of plants in geological times, the first land plants, man and the plant world, and the several climatic zones, give a useful summary of our knowledge of and the factors controlling the present distribution of plants.

It would have been useful for the more botanical reader had Dr. Campbell given the scientific names of some of the plants, to which he refers only by their popular names—names with which American botanists, no doubt, are quite familiar. It would also have been more convenient if data relating to rainfall, altitude, and temperature were given consistently either in the metric or English system. These, however, are only minor points in a very readable book, which is so readable because not only is it very well written, but also because the author writes with a personal knowledge of the vegetation of nearly every part of the world.

Civil Engineering Specifications and Quantities. By Dr. G. S. Coleman and G. M. Flood. Pp. xv + 282. (London: Longmans, Green and Co., Ltd., 1926.) 10*s.* 6*d.* net.

The administration of contracts is one of the most arduous duties of the civil engineer, and this book should be of distinct value to those of limited experience. An engineering contract may be divided into two parts, one legal and the other technical, and the book is roughly arranged to correspond. The legal sections, comprising ten chapters, are clearly written and illustrated by cases, but such legal expressions as "time is the essence of the contract, *prima facie*, *quantum meruit*," though commonplace to lawyers, are not always clearly understood by engineers, and a short explanation of them would enhance the value of the book. The technical chapters give suggested specification clauses for most of the general work carried out by civil engineers in excavation, embankment, concreting, masonry, brickwork, and steelwork.

The practice referred to is, as might be imagined, that common in the north of England, and in a few details would be modified in the south. The suggestion on p. 96 to paint reinforcing rods is rather unusual, and does not correspond with the advice given on p. 147. It would perhaps have been worthy of mention that wood street-paving blocks are laid with the grain vertical. The section on quantities is clear and straightforward. In essentials, building contracts and engineering contracts are similar, and a reference might have been made to the standard conditions of contract of the Royal Institute of British Architects, and to the standard method of measurement of building works of the Surveyors' Institution, which are often used as models for small engineering contracts.

E. E. MANN.

Types of Mind and Body. By E. Miller. (Psyche Miniatures, Medical Series, No. 4.) Pp. 132 + 5 plates. (London: Kegan Paul and Co., Ltd., 1926.) 2*s*. 6*d*. net.

THIS attractive little volume is an excellent introduction to the scientific study of the psychophysics of temperament and character. It deals in a critical and independent manner with the best recent work on types of physique and mentality, and also contains many interesting suggestions towards new lines of thought and investigation. Dr. Miller lays special stress, as is natural, on the work of Kretschmer, but he by no means neglects the work of the French and other schools. Perhaps the most important section is that which deals with the 'physiological background,' which gives, among other matters, a useful account of the functions of the internal secretions in relation to character and behaviour. Especially suggestive is Dr. Miller's discussion of the endocrine system as a link between metabolic processes and neural and mental processes, which throws light not only on the relation between mental and physical forms, but also on the more general problem of the relation between mind and body.

There are some interesting remarks about the relation between the types distinguished by recent workers and the racial types of the anthropologists, which need fuller justification. So far as is known, much the same types of temperament and character exist among all races of mankind, and this is scarcely compatible with anything like a simple correspondence between the two kinds of types. In th psychological section there are some points whic raise doubts, as, for example, the alleged relatio between the ego-instincts and introversion, an between the sex-instincts and extroversion, but o the whole the treatment is both balanced an stimulating. There is a very well-chosen bibli graphy.

MORRIS GINSBERG.

Exercises in General Chemistry and Qualitati Analysis. By Prof. H. G. Deming and Pro S. B. Arenson. Second edition, revised. Pp. x +282. (New York: John Wiley and Son Inc.; London: Chapman and Hall, Ltd., 1926 9*s*. net.

THE authors of this manual express the "opinio that quantitative work in an elementary cour often consumes time that were better spent in th accumulation of useful and necessary qualitativ information." Quantitative work is therefor reduced to a bare minimum and a scheme for th qualitative investigation of chemical phenomen covering a fairly wide field, has been elaborate A novel feature is the introduction of linear scal showing the relationship between the temperatur and the vapour-pressure of water and between th density and the concentration of several commo reagents. Working directions are minutely specifie and almost every page is liberally sprinkled wit cross-references, which are likely to bewilder th student, whose natural desire to discover things fo himself is stifled by the warning in heavy type tha ***all unauthorised experiments are strictly forbidde*** Yet the authors hope to "foster something of th research spirit at an early age"! About one fourth of the book deals with ordinary qualitativ analysis, this section being prefaced with th following instruction to the beginner: "The wor is based on differences in solubility. Commit t memory the table of solubilities and get some clas drill in its applications." Such methods will no appeal strongly to teachers in English schools.

A Junior Inorganic Chemistry. By R. H. Spea Second edition. Pp. viii + 392. (London: J. an A. Churchill, 1926.) 6*s*. 6*d*. net.

THIS little book, which is designed for junior form appears to possess no strikingly original feature It is, however, lucidly written and it contains a fai number of illustrations, though some of them ar rather crude. There appears to be no direct reference to Fig. 13 in the text, nor is it clear to the reade that the rather wide tube dipping into the beake in all probability represents a thermometer. Again the muffle-furnace, depicted on p. 59, needs som explanation in the text. Some of the headlines ar badly worded or even startling. Thus on p. 27 a paragraph of about five lines is headed "To show that Matter is not Created by the Rusting of Iron." The investigation of the rusting of iron in a late chapter is fairly good, but it might have bee carried a stage further by considering the action o air-free water upon the metal. The weight of a litr of air is given incorrectly on p. 24 as 0·001293 gm

Letters to the Editor.

The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*]

The Atomic Weight of Silver.

IN reply to Prof. Brauner's criticism (NATURE, Mar. 5, p. 348, and April 9, p. 526) of our determination of the atomic weight of silver (*J.C.S.*, 1926, 128, 2510), we have now investigated the volatility of silver and have most emphatically confirmed our original statement that no silver could possibly have escaped from the silica tube during the final melting in hydrogen.

Some finely divided silver, prepared by heating the oxide in air to 350°-400° C., was introduced into the silica tube shown in the diagram (Fig. 1). The tube was heated in the electric furnace for an hour at 700°-800° C., for a similar period at 800°-900° C., and finally for five hours at a temperature of 1000° C., whilst a slow stream of hydrogen passed through the tube and bubbled through the dilute nitric acid (1HNO$_3$: 2H$_2$O). The nitric acid was then poured into a nephelometer tube and a little dilute potassium bromide solution added. On examination of the nephelometer no turbidity could be detected, even after standing for several hours. On the addition of 0·2 c.c. of N/1000 silver nitrate (0·02 mgm. silver) an immediate and comparatively dense turbidity developed.

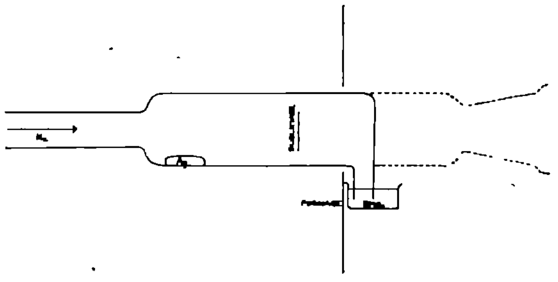

FIG. 1.

Taking into consideration the relative sizes and positions of the silica tube as used in the atomic weight determination (shown by dotted lines in Fig. 1), and the silica tube used in this experiment, also the time of heating, which was only twenty minutes in the determinations, then it is quite conclusive that no silver could possibly have escaped from the original silica tube.

On examination of the tube after the experiment, an extremely minute sublimate was observed 3 cm. from the silver bead, showing that the silver is slightly volatile, but not to anything like the extent suggested by Prof. Brauner.

Our preliminary investigations on the decomposition of silver oxide showed that it was essential to melt the silver in hydrogen after the initial decomposition. Silver, prepared from silver oxide by heating at 400° C., is a coherent mass full of voids. It could almost be called sintered. The loss in weight on melting in hydrogen was between 2 mgm. and 3 mgm.

In estimating the weight which ought to be attached to any determination of a constant such as an atomic weight, we would suggest that it is only the experimental facts which deserve consideration. Our determination of the atomic weight of silver has an advantage over others, in that it is the only one in which the direct ratio of silver to oxygen has been measured.

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Radioactivity and the Heat of the Earth.

IN a previous letter to NATURE (vol. 119, p. 277, 1926) I have discussed Dr. J. W. Evans's suggestion that the existence of pleochroic haloes in mica indicates that much of the energy of the rays from the radio-elements in rocks is used up in producing physical, chemical, or atomic rather than thermal changes in the surrounding minerals. I concluded that the close agreement between the calculated and measured heat productions of the radio-elements affords strong evidence for the view that "practically the whole of the energy associated with the radiations emitted by these elements is available for raising the temperature of the rocks in which they occur." In a later communication (NATURE, vol. 119, p. 424, 1926), Dr. Evans infers that if measurements of the heat production of radium were carried out in a mica container instead of in a glass tube, the results of experiment and theory might not show such good agreement, in spite of the fact that the fluorescence effects and colorations produced by the radiations and the thermo-luminescence resulting from subsequent heating of the coloured materials are quite analogous for the two substances. From the view-point of geothermal problems, the importance of an unequivocal decision on the question at issue is perhaps sufficient justification for my returning to the subject, for several independent lines of thought support the conclusion arrived at in my previous letter.

Since it can be obtained in very thin uniform sheets, mica has always been used extensively in absorption experiments with α-rays; its behaviour is perfectly normal. The calculated range of α-particles in mica, as in glass and aluminium, is in good agreement with that found by experiment. This we should not expect if the behaviour of mica as regards absorption were abnormal. In such a case, either each α-particle would lose an appreciable amount of its energy in promoting, say, *chemical* change and the observed range in mica would be smaller, or the α-particles would lose different amounts of energy in this way, when the range would be indefinite, in opposition to observations of pleochroic haloes where the range is sharply defined. Furthermore, the proportion of the energy of α-rays utilised in promoting *atomic* changes in mica must also be very small, for mica has been used extensively in absorption experiments on atomic disruption, and the number of H-rays observed, particularly when the mica has been outgassed, is insignificant for present purposes.

Dr. Evans mentions that Dr. Alfred Brammell found it necessary to keep biotite at a dull-red heat for about six hours to render the pleochroic haloes invisible; but here I think he has misunderstood my previous reference to the thermo-luminescent effects with minerals coloured by radioactive radiations. When coloured glass or minerals are heated appreciably, but below dull-red heat, the thermo-luminescent effect is of relatively short duration, and may often be designated a flash. My statement that the energy liberated during the process is "manifestly small" was based primarily on visual impression, but it is supported by the fact that if an appreciable proportion of the radioactive energy from an inclusion were stored in the pleochroic sphere and liberated on heating, the energy so released would correspond to a flash of intensity about 10^{18} times greater than that necessary to excite the retina of the eye. Moreover, Duane has shown that when radium is mixed with a material which fluoresces strongly under the action of the rays emitted, the measured heat production is identical with that obtained with radium alone,—a result which surely admits of no other interpretation than that the energy of luminescence is negligibly small.

Quartz, and to a less extent glass, when subjected for a long time to intense radiation from radium, develops tiny fractures or cracks which can be removed by continued heating above the softening point of the material, just as devitrified glass can be restored to condition by suitable heat treatment. I am inclined to attribute Dr. Brammell's observation to an analogous mechanical effect in the mica, the original crystal lattice being restored by the later heating at dull-red heat. Markings in the outer shell or in the body of the pleochroic sphere might also arise from the escape of gases on the application of heat. Thus for a representative sphere (radius of sphere $= 30\ \mu$; radius of inclusion $= 1\ \mu$; age $= 500$ million years) the volume of helium available in the outer shell, neglecting diffusion, would be about thirty times the volume of the inclusion, and the oxygen contained in the mica of one-thousandth part of the pleochroic sphere would occupy a volume equal to that of the sphere.

The evidence of heats of formation also renders it probable that most of the radioactive energy is converted into heat in the mica, for the calculated amount of heat available from radioactive sources during the life of the pleochroic sphere of the above-mentioned dimensions has about twice the value of the heat of formation of a volume of water equal to that of the sphere. The heat of formation of mica is unknown, but on the assumption of an additive law for the constituent parts, I find that the radioactive energy liberated within the pleochroic sphere is of the same order of magnitude as the estimated heat of formation of an equal volume of mica.

It is observed that for each gram of radium some thirty or more cubic centimetres of electrolytic gas are produced daily in an acidified aqueous solution of radium, the requisite energy being derived primarily from the α-particles emitted. Knowing the heat of formation of water and the daily heat development of radium, we can readily deduce that only about two per cent. of the energy of the radioactive rays is used up in promoting chemical change in the solvent. When an identical amount of radiation acts on ice, the resulting amount of chemical change is much less than in the case of water, and for a stable mineral like mica it seems reasonable to conclude that the amount of chemical change produced will be exceedingly small.

The concordance of evidence advanced in this and in my previous letter is very strongly opposed to the views expressed by Dr. Evans, and I shall only briefly refer to the latter part of his letter. He points out that the presence of extensive granite and gneiss in and below the deep boring at Dubbelde Vlei, in the Cape Province of South Africa, seems to have had no appreciable effect on the temperature gradients. In the absence of actual measurements of the radioactivity of these rocks, however, it would be futile to attempt to discuss the above observations of temperature gradient, though it seems not unlikely that low radioactivity is the reason for the low gradients. The thickness of the granitic and basaltic layers, however, will also exert an influence. Prof Holmes has referred to the gradient difficulty in two recent papers (*Geol. Mag.*, vol. 62, p. 533, 1925 vol. 63, p. 313, 1926) without coming to a decision as to the cause; but he is also convinced that anomalous absorption of the radioactive rays is insignificant in this connexion, and that practically the whole of the energy of the radiations from the radioactive substances in igneous rocks is available for raising or maintaining the temperature of those rocks.

It is to be hoped that before long additional evidence will be obtained on the question of the temperature gradients associated with, and the radioactivity of, the granitic layer in different parts of the world. Meanwhile it is interesting to recall that high gradients are associated with the highly radioactive granitic rocks of the Simplon tunnel, and that independently of the petrographic nature of the dominant rock type, some regions of the earth's surface are known to be characterised by more intense radioactivity (*e.g.* the Alps) than others (*e.g.* New Zealand). In future discussions it will be necessary to take account of the well-established radioactivity of potassium in this connexion, for in igneous rocks the thermal effect of potassium appears to be of the same relative importance as that of uranium or thorium. Robert W. Lawson.

University of Sheffield.

The Energy of Photo-electrons produced by Soft X-rays.

In a series of experiments carried out in Prof. O. W. Richardson's laboratory at King's College, London, I have attempted to measure the velocity of the photo-electrons set free from a metal under the influence of soft X-rays, excited in the usual way by electrons from a hot filament falling on the radiator through an accelerating potential difference of 50-800 volts. The results obtained with the stopping-potential method—in which a varied retarding potential is applied to a surrounding electrode, thus preventing all electrons with a kinetic energy below the corresponding value to escape—are difficult to interpret because of the masking effect of scattered radiation on the measurements for higher voltages. Various forms of magnetic methods have also been tried, of which the last one has yielded definite results. In this apparatus the photo-electrons are emitted from a narrow rod forming the axis of a short cylindrical ring, connected to the electrometer and kept at the same potential as the rod. A variable magnetic field, applied in the direction of the axis, prevents electrons with velocity less than a certain value from reaching the cylinder.

In the measurements so far obtained, the potential on the tube was 700 volts. The anode-radiator was of carbon and the rod of copper—clean or covered with a thick coating of lamp-black. In both cases the curves show that the preponderance of low-speed electrons in the emission is very great indeed. More than 70 per cent. of all the electrons emitted have energies less than 10 volts. The following is a typical set of values showing the relative number of electrons within an equal interval in volts for different points on the distribution curve:

Energy (volts) . .	2	5	8	20	50	100	150	200 volts.
No. of electrons . .	100	41	14	2·5	1·6	0·7	0·5	0·3

It may be that this low average energy of the electrons results from the greater part of the incident diation being of comparatively great wave-length. On the other hand, recent experiments by Simons roc. *Phys. Soc. London*, 37, 58; 1925) with ordin-y homogeneous X-rays have shown that in this case also a great part of the photo-electric emission onsists of slow-moving δ-particles.

In both cases it is possible that the process by hich the large quanta of energy carried by the xciting electrons are transformed to small quanta of he photo-electrons, involves some kind of a compound hoto-electric mechanism. According to Auger (*Ann., e Phys.*, 6, 183; 1926) the compound photo-electric ffect should play a very important part in the soft -ray region.

The investigation is being continued with the object of gaining further knowledge on this point.

ERIK RUDBERG.

Stockholm, Odengatan 8,
April 19.

Correlation Coefficients and the Theory of Mental Abilities.

SINCE the discovery by Spearman of hierarchical order in correlations between mental tests, the theory of mental ability has been actively explored. Mathematical methods have been made possible by regarding mental abilities as variables composed of certain constituent factors which are distributed unequally among individuals. The extent to which such factors of mental ability may be called into activity will pre-umably depend on their use in any given situation.

According to this view, we may suppose that any given test will require for its solution a number of factors of ability. If two tests are applied, more factors will as a rule come into activity, but possibly some will assist in both tests and thus produce correlation between the results. If three tests are applied, three orders of factors may be expected according as they are common to all three, or to only two out of three, or are relatively specific, *i.e.* applying to one ut of three. If four tests are used, four orders of factors might be expected; if five, then five orders, and so on. In any particular collection of tests, whether three or more, we regard the terms 'specific,' 'group,' nd 'general' as referring to factors that are respectively (1) present only in one, (2) present in some, 3) present in all the mental processes required for the performance of those tests. In the furthest limit, when all possible variables have been considered, and provided their constituent parts could be known, the final and indivisible elements would stand out as the ultimate analysis of mental ability. However near so or remote from the actual truth this view may be, it forms an adequate method of constructing corre-ated variables, and is therefore of assistance in checkng the interpretations that are placed upon correation coefficients derived from experimental data.

The possibilities involved in the co-operation of onstituent elements in either three or four tests have been examined by the writer, partly in conjunction with Prof. Godfrey H. Thomson of the University of Edinburgh ("The Essentials of Mental Measurement," Brown and Thomson, also *Brit. Jour. Psych.*, 919). In the case of any three correlated variables constructed on lines described above, the expression $r^2_{12} + r^2_{13} + r^2_{23} + 2r_{12}\,r_{13}\,r_{23}$ (where r_{12} is the coefficient of correlation between the first and second variables, r_{23} between the second and third, and so on) has been hown to possess special significance. Disregarding negative correlation, the limiting values for the expression are zero and five. If, however, no general factor exists between any three variables, the maximum value for this expression is unity, and any value above unity definitely indicates the presence of a general factor, while any value below unity could be produced either with or without a general factor. When the value of the expression is exactly unity we have, in this sense, a boundary condition for three variables.

In proving this boundary condition, in the first place, the following restrictions on the nature of the elements were assumed: (1) That they were normally distributed with equal standard deviations, and (2) that, when present, they acted with full effect, never with a fraction or component, as it were, of their total strength. With this second restriction removed, however, it is still true that the expression could not be greater than unity without the aid of a general factor, and any other value, unity or less than unity, can be produced with or without the aid of a general factor.

So long as the 'all or none condition' is imposed, the expression is equal to unity (general factor absent), in every case when specific factors are absent, group factors alone remaining. In the wider conditions, however, the internal construction of the group factors must conform to certain laws before the maximum value is reached. The actual details of these laws, under which the 'all or none condition' is one particular case, will, I hope, be published at an early date.

A similar inquiry has been made in the domain of four variables. Here, two boundary conditions claim attention: (1) concerning the absence of a general factor and group factors common to three out of four variables, and (2) concerning the absence of the general factor alone. For the first boundary condition we have the expression $r^2_{12} + r^2_{13} + r^2_{14} + r^2_{23} + r^2_{24} r + r^2_{34} - r^2_{12} r^2_{34} - r^2_{13} r^2_{24} - r^2_{14} r^2_{23} + 2r_{12}\,r_{13}\,r_{23} + 2r_{23}\,r_{24}\,r_{34} + 2r_{13}\,r_{14}\,r_{34} + 2r_{12}\,r_{14}\,r_{24} + 2r_{12}\,r_{13}\,r_{24}\,r_{34} + 2r_{13}\,r_{14}\,r_{23}\,r_{24} + 2r_{12}\,r_{14}\,r_{23}\,r_{34}$. The maximum value for this expression, without the aid of general or group factors common to three variables, is unity, and at or below unity these factors are unnecessary.

The second boundary condition requires the same expression except that the first six terms, and also the tenth to the thirteenth, all take 4 as a numerical coefficient. Such an expression possesses 16 as a maximum value without a general factor, and at or below 16 a general factor is unnecessary. Both these boundary conditions are of course true without the 'all or none' restriction.

The above studies are intended to illustrate how far inferences may be safely drawn from experimental data in the form of correlation coefficients.

J. RIDLEY THOMPSON.

University of Sheffield.

Iron Crystals.

IT has been found possible to grow long crystals in iron wire by making use of the allotropic transformation which occurs at about 900° C. The method is to heat a portion of the wire between two mercury contacts by passing direct or alternating current through it and then to cause the heated portion to travel along the wire either by moving the support carrying the contacts or by moving the wire itself. The hottest part of the wire should be at 1400° C. or higher. Under these conditions a very steep temperature gradient exists at the point where face-centred cubic (γ) crystals, stable at high temperatures, are being replaced by body-centred cubic (α) crystals, stable at lower temperatures, and at a favourable velocity of travel a single α-crystal will grow to a length of 20 cm. or more in wire 1 mm. in diameter.

Crystals have been grown in a vacuum and in an atmosphere of nitrogen, but the best results have been obtained in hydrogen at atmospheric pressure. The rate of travel principally used has been about 4 cm. an hour, but higher and lower rates have also given good results. The chemical purity and previous mechanical history of the iron seem relatively unimportant. Most of the experiments have been made on remelted electrolytic iron, but impurities usual in commercial iron do not inhibit growth. In a particular experiment, long crystals were grown in hard-drawn piano wire containing originally 0·8 per cent. carbon. In the final state the amount of carbon had been reduced, but, as judged by resistivity measurements, the carbon content was probably still greater than 0·3 per cent.

The large crystals occupy the whole cross-section of the wire, there being no surface layer of fine crystals as is usual in crystals grown by over-strain with subsequent annealing. Etching with nitric acid develops planes of the form {100}, so that an optical goniometer serves to locate the cubic axes normal to these reflecting surfaces. The orientations so found have been checked by X-rays, which permit more exact location than does the optical method. A considerable variety of orientations has been obtained, and it cannot yet be said whether there is any preferred orientation.

Irregularity in tension on the wire and torsional stresses in it result in twinning. Twins may either appear as small inclusions or as complete changes in orientation with the twinning plane traversing the entire cross-section of the wire. The twinning plane is of the form {211}.

The magnetic and magnetostrictive properties of long crystals free from twins are being investigated. These properties appear in some respects to differ from those of crystals prepared by others[1] by the method of over-strain and annealing. The initial permeability of nearly carbon-free crystals grown in hydrogen lies between 2000 and 2500, the maximum permeability is around 20,000, and the coercive force about 0·2 gauss. After treatment which should remove hydrogen (its actual removal has not been proved) the initial permeability drops to a few hundred, the maximum permeability rises to nearly 40,000, and the coercive force diminishes slightly. A crystal grown from piano wire in hydrogen and not further treated had an initial permeability of about 1000, but was otherwise much like the purer crystals in magnetic behaviour, though stronger mechanically. The dependence of properties upon crystal orientation in the wire, and the behaviour in fields of more than 50 gauss, have not yet been determined.

Plastic deformation of the crystals, even to the slightest extent, causes considerable changes in their magnetic behaviour, and restoration of the original condition by annealing seems only to be possible when the amount of deformation has been minute.

The method is being extended to iron alloys possessing in the cold the body-centred structure characteristic of pure iron and having an allotropic change at nearly the same temperature.

L. W. MCKEEHAN.

Bell Telephone Laboratories,
New York, N.Y.,
Mar. 2.

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[1] Webster, W. L., NATURE, 117, 859 (1926), *Proc. Roy. Soc.*, 107A, 496-509 (1925), 108A, 570-584 (1925); 113A, 196-207 (1926). Gerlach, W., *Phys. Zeit.*, 26, 914-915 (1925): *Zeit. f. Phys.*, 38, 828-840; 39, 827-831 (1926). Honda, K., Kaya, S., Masuyama, Y., NATURE, 117, 753-754 (1926). Honda, K., Kaya, S., *Sci. Rep. Tohoku Univ.*, 15, 721-753 (1926). Honda, K., Masuyama, Y., *Sci. Rep. Tohoku Univ.*, 15, 755-776 (1926).

The Transmutation of Hydrogen into Helium.

A FEW months ago, K. Peters and I published a account of experiments we had made in an attemp to transmute hydrogen into helium (*Ber. d. Deutsche Chem. Ges.*, 59, 2039; 1926). A more or less detaile account of this publication appeared in the colum of NATURE (vol. 118, p. 526, 1926), and perhaps may be permitted to refer to a more recent publicatio on the same topic by K. Peters, P. Günther, an myself (*Ber. d. Deutschen Chem. Ges.*, 60, 808; 1927 In this communication, as a result of further experiments, we feel that we are in a position to giv an explanation of the occurrence of the observe very small quantities of helium in our experiment without having recourse to the assumption of synthesis of helium.

In the first-mentioned communication we considered the penetration of helium from the atmospher through the glass walls of the apparatus to be th most likely source of trouble in such experiment and we excluded this possibility by the use of vacuu jackets, immersion in water, and similar device In addition, we also discussed the possibility regarding the helium dissolved in the glass as a explanation of the observed effects, but blank experiments led us to the conclusion that the quantit of helium capable of being liberated in this way we beyond the limits of sensitivity of our method detection. In the interval we have carried ou experiments both in the Baker Laboratory of Corne University and in the Chemical Laboratory of th University of Berlin, and these have shown that th liberation of helium from glass (and from asbesto is dependent on the presence of hydrogen. Thu glass tubes which gave off no detectable quantitie of helium when they were heated in a vacuum or oxygen were found to yield helium in quantities the order of 10^{-9} c.c. when they were heated in a atmosphere of hydrogen. Now in the earlier experiments the glass tubes containing palladium yielde helium, whereas the empty glass tubes used in contr experiments did not; and since the former tube would fill with hydrogen on the application of heat we see that the source of the helium lay not in th palladium but in the glass, in spite of appearance to the contrary.

Our method of detecting helium is sufficientl sensitive to show that a glass tube which has bee completely freed from its content of helium b heating in hydrogen takes up a detectable amoun of neon-free helium from the atmosphere even afte only one day's contact with the air.

Since asbestos behaves similarly to glass, we no see why one particular palladium preparation, bough as palladium-asbestos, yielded larger quantitie (10^{-7} c.c.) of helium after being charged with hydroge Here, obviously, in contrast to the preparations w made ourselves, the asbestos had not been ignite until it was free from helium, and a fraction of th residual helium was always liberated by heating whe the palladium was charged with hydrogen, wherea in oxygen no development of helium could be observed

As a result of our more recent experiments we hav thus established that, in using an apparatus made o glass, one cannot make any trustworthy statemen as to the origin of 10^{-9} c.c. of helium if air come in contact with the apparatus, parts of which ar later heated in hydrogen. By avoiding all heatin of the apparatus, we shall endeavour to decid whether a transmutation of hydrogen into heliu of the order of 10^{-9} c.c. or less takes place. In an case, the amount of helium formed in experiment on electric discharges, as tested by various worker id by ourselves, and in experiments on the action palladium, does not reach the order of magnitude 10^{-8} c.c.

It is scarcely necessary to emphasise the fact that e sensitiveness of our method, though limited to 0^{-8} c.c., is sufficient to decide with certainty the ther questions dealt with in our first communication, ich as the helium content of meteorites, the helium evelopment of radioactive deposits, and so on.

Fritz Paneth.

Berlin, Mar. 2.

Measurement of Radiation Intensity by Photographic Methods.

In a letter to Nature of Jan. 16, 1926, p. 83, Dr. C. Toy criticised the use of calibration curves in hotographic spectro-photometry; but the grounds of his objections were rather the difficulties in the way of adequate calibration than any quarrel with he main assumption involved, namely, the essential uniformity of the plates of a single batch. Recently, owever, Miss C. H. Payne and Mr. F. S. Hogg have oncluded that each of their plates requires separate alibration, a conclusion fully borne out by the sample urves given by them in Harvard Circular 301.

The work at this Observatory in connexion with Prof. Sampson's method of stellar spectro-photometry as been free from trouble due to the variations of ndividual plates: indeed, the curves for different atches of plates, on the similarity of which no eliance is placed, are far more consistent than those of individual plates at Harvard. Fig. 1 shows the calibration curves for wave-length 6100 Å.U. of the five batches of plates of the same make used during the last three years. It will be noticed that the differences are confined to the transparencies smaller than 20 per cent., that is to say, to the region which is strongly affected by the duration and temperature of development. A much closer agreement would have resulted had the first and fourth batches received somewhat longer development. The differences found at Harvard are of a totally different character, affecting the whole curve. In this respect they strongly resemble those found by Messrs. L. A. Jones and E. Huse (Eastman Kodak Research Laboratory Communication No. 193), which were eventually traced to different batches of chemicals used in making up the developer.

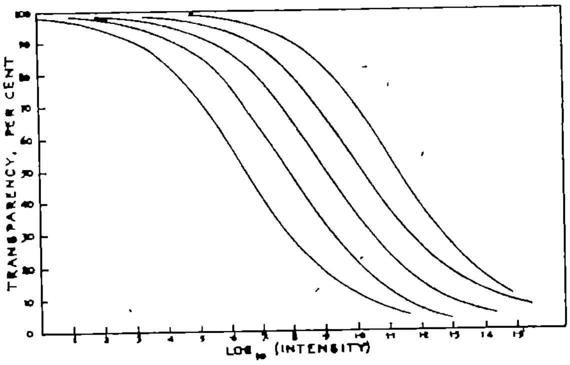

Fig. 1.

This suggests that these variations of individual plates may be due to the sensitiveness of the emulsion to slight changes in the composition of the developer, in which case a change of developing agent might lead to consistent results.

E. A. Baker.

Royal Observatory, Edinburgh,
April 16.

Ionisation Potential of Hydrogen Fluoride.

The ionisation potential of hydrogen fluoride has not yet been worked out experimentally. Several attempts have been made to calculate it on thermochemical data, on the assumption that hydrogen fluoride is ionised into H^+ and F^-. Such a calculated value, notably by Glocker (*Phil. Mag.*, 1924), appears to be 15·67 ± 0 7 volts.

Such a process of ionisation with molecular dissociation at the lowest ionisation voltage has been doubted by Mackay (*Phys. Rev.*, 1924), who has stated that even in the cases of those hydrogen halides where thermochemical data have yielded results in accord with experiment, the coincidence may be fortuitous. It has also been shown by Duffendack (*Phys. Rev.*, 1925) that "even with an intense arc in HCl vapour up to 70 volts, no trace of hydrogen spectrum could be obtained."

I have calculated the ionisation potential of fluorine, F = 16·7 volts (*Phys. Rev.*, awaiting publication). This calculated value seems to be justified by Prof. H. Dingle's recent observation of the ionisation potential of the neutral fluorine atom (approx. 17·0 volts) (*Proc. Roy. Soc.*, A, 113. 323). Ionisation values of hydrogen chloride, bromide, and iodide are all found to be greater than the corresponding values of chlorine, bromine, and iodine; and hence one is led to believe that the ionisation potential of hydrogen fluoride may also be greater than 16·7 volts or that the thermochemically determined value is too low.

On the other hand, there is reason to believe that the ionisation products of hydrogen fluoride may be $(HF)^+ + e$. This is the same kind of ionisation as that of the neon atom into $(Ne)^+ + e$. Hydrogen fluoride and neon are known to have a similar structure and an exactly similar disposition of outer electrons. In the case of hydrogen fluoride, the nuclear distance between the atoms is known to be greater than the atomic radius of neon (Bragg and Bell, Nature, Mar. 24, 1921, p. 107), and thus the ionisation potential of hydrogen fluoride may be expected to be nearly equal, though somewhat smaller than that of neon (21·5 volts).

On the present view of ionisation in hydrogen fluoride, it can be shown on the Bohr-Sommerfeld theory that

$$I_{HF} \cdot (r^2_{HF}) = I_H \cdot (r^2_H) \cdot n.k.$$

where I_H and r_H stand for ionisation potential and radius of the normal (1, 1) orbit of hydrogen respectively, and I_{HF} is the ionisation potential of hydrogen fluoride and r^2_{HF} is the mean square radius of the outer n, k electron orbit of HF.

By this method of calculation $I_{HF} = 18 \cdot 04$ volts, $I_{HCl} = 13 \cdot 8$ volts.

S. C. Biswas.

Physics Laboratory,
D.A.V. College, Lahore,
Mar. 31.

The Nuptial Pad of Kammerer's Water-bred Alytes.

I was delighted to read in Nature of April 30, p. 635, a letter from Dr. Przibram vindicating the validity of Kammerer's results.

May I direct attention to one feature in the much-discussed Alytes which renders the assumption of fraud absurd?

This specimen when I saw it in 1923 showed a nuptial pad only *on one side*. Who, if he had wished to 'fake' an Alytes so as to deceive the public, would treat *one* palm only with Indian ink?

E. W. MacBride.

Imperial College of Science and Technology,
South Kensington, London, S.W.7.

The Fields of Force in the Atmosphere of the Sun.

By Dr. GEORGE E. HALE, For. Mem. R.S.

THE structure of the solar atmosphere above and surrounding sunspots has been illustrated in a previous article in NATURE.[1] Single spots often lie at the centre of an apparent vortex resembling a terrestrial tornado or cyclone, sometimes nearly radial in form, more commonly showing marked clockwise or counter-clockwise curvature Bipolar spots (Fig. 1) are often surrounded by a field of force similar to that of a bar magnet, though in many cases the structure is very different. I have recently discussed the nature of these fields of force,[2] but the evidence, which favoured a hydrodynamical rather than an electromagnetic explanation, was inconclusive, especially in view of the prevalence of the bar magnet type so frequently associated with bipolar spots. This seemed to point to an electromagnetic origin, and the impossibility of analysing adequately the structure of the hydrogen flocculi in these bipolar fields has greatly impeded progress.

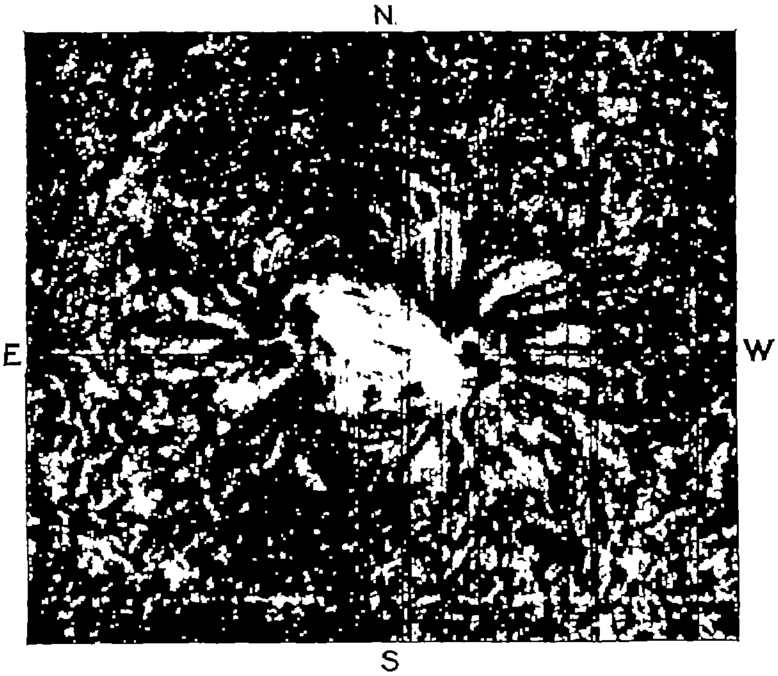

FIG 1.—Field of force in the hydrogen atmosphere surrounding the bipolar spot of Aug 29, 1924. The structure of the hydrogen flocculi resembles the field of force surrounding opposite magnetic poles.

In the study of this problem the spectrohelioscope, described in its preliminary form in my earlier article in this journal,[1] has proved to be indispensable. The spectroheliograph remains our best means of photographing the fields of force in the solar atmosphere; but as a device for detecting certain hitherto unrecognised phenomena, and of interpreting many puzzling questions, it is greatly surpassed by the spectrohelioscope. For exampl during the last few months the spectrohelioscop has permitted me to observe repeatedly the rapi flow of large hydrogen flocculi toward sunspots, phenomenon clearly recorded on a large scale bu once in many years of work with the spectrohelio graph. Moreover, it has also enabled me t measure the radial velocity of this inflowing gas yielding results much higher than the Evershe effect would lead one to expect, but in good genera agreement with the velocity of inflow of promi nences photographed in elevation at the sun's lim by Slocum and Pettit with the Rumford spectro heliograph. It has also enabled m for the first time to distinguis quickly and clearly between thes inflowing streams and the outflowing jets which often result in arched prominences. By rendering possible a study of thes arches, seen in projection agains the disc, it has shown that the 'ba magnet structure' surrounding bipolar spots is not necessarily an electromagnetic effect.

THE ELECTROMAGNETIC THEORY.

In 1912, at my request, Prof. Carl Stormer visited the Mount Wilson Observatory to investigate the theory of the fields of force shown by the hydrogen flocculi. I quote from his paper entitled "Researches on Solar Vortices"[3]:

> "The detailed study of the collection of spectroheliograms made at the Observatory suggested to me an application of the classical researches on terrestrial cyclones made in 1876 by my countrymen Guldberg and Mohn. The hydrogen flocculi seemed to be arranged around a single spot in curved paths that were very similar to logarithmic spirals; and just the same curves were found by Guldberg and Mohn as trajectories of the air particles in the outer part of cyclones. It therefore seemed advisable to start with the hypothesis that the motion of charged electric gas molecules takes place along such spirals around the sunspot centre, and compute the resulting magnetic field.
>
> "This investigation which I made in Pasadena showed that the lines of magnetic force due to a plane whirl of the kind mentioned above are space-curves whose projections on the plane of the whirl are also logarithmic spirals intersecting the first at right angles.
>
> "This result led me to the idea first advanced by Brester in 1909, that the hydrogen flocculi resemble terrestrial auroras, thus implying that the visible whirls are not real current-lines, but lines of magnetic force due to a magnetic field at a lower level—a view expressed by Deslandres in 1910. Professor Hale had previously stated in his papers that the Zeeman effect

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[1] "Some New Possibilities in Solar Research," NATURE, July 3, 1926, Supp. p. 1.

[2] "A Test of the Electromagnetic Theory of the Hydrogen Vortices surrounding Sunspots," *Communications from the Mount Wilson Observatory*, No. 95; *Proc National Academy of Sciences*, 11, 691; 1925.

[3] *Contributions from the Mount Wilson Observatory*, No 109; *Astrophysical Journal*, 43, 347, 1916.

was probably due to a low-level vortex. In accordance with the mathematical result mentioned above, the current-lines of this hypothetical whirl at a low level would be logarithmic spirals tending more and more to become circles according as the structure of he hydrogen whirl tended to be radial. This would much better explain the strength of the Zeeman ffect of sunspots of radial structure."

Störmer's theory was developed merely as a working hypothesis and not as an expression of his opinion regarding the nature of these phenomena. According to the theory, the direction of the apparent whirl shown by the hydrogen flocculi (curvature of the projected lines of force), clockwise or counter-clockwise, hould depend upon he sign, motion, and direction of the invisible low-level elecric current surroundng the spot. As I have shown elsewhere,[1] a considerable modification of Störmer's theory, which was tentative in character and unavoidably based upon nadequate observaional data, would be necessary in order to adapt it to the conditions as now known. If such modification be possible, the direction of curvature of he lines of force (and hence of the hydrogen locculi supposed to ollow them), clockwise or counter-clockwise, must conform with the magnetic polarity of the spots in question, if two reasonable assumptions are permissible. These assumptions are that the sign of the charge of the particles producing the field, as well as the direction of any radial component of motion, inward or outward, are invariable in all single spots and in the preceding spots of bipolar groups. While the evidence is insufficient, there seems to be no reason to doubt the validity of these assumptions. We may thus have a simple criterion which should enable us to determine whether the apparent vortices in the solar atmosphere surrounding single spots represent the lines of force of their magnetic fields. If so, the direction of curvature, clockwise or counter-clockwise, should be determined by the polarity of the field in question.

In the paper just cited, I have given the results of a preliminary test, based upon an examination of 51 hydrogen whirls photographed at Mount Wilson on various dates scattered over the period 1908–1924. Summarising the polarities and directions of whirl without regard to date, spot-type, hemisphere, or latitude, we find:

No. of spots.	Polarity.	Direction of whirl
9	N	Clockwise.
16	N	Counter-clockwise.
13	S	Clockwise.
13	S	Counter-clockwise.

These results thus offer no support to the electromagnetic hypothesis. The same results, however, when grouped for the northern and southern hemispheres, show that 81 per cent. of the northern whirls are counter-clockwise and 84 per cent. of the southern whirls are clockwise, irrespective of the magnetic polarity of the accompanying spot, thus agreeing in direction with terrestrial cyclones.

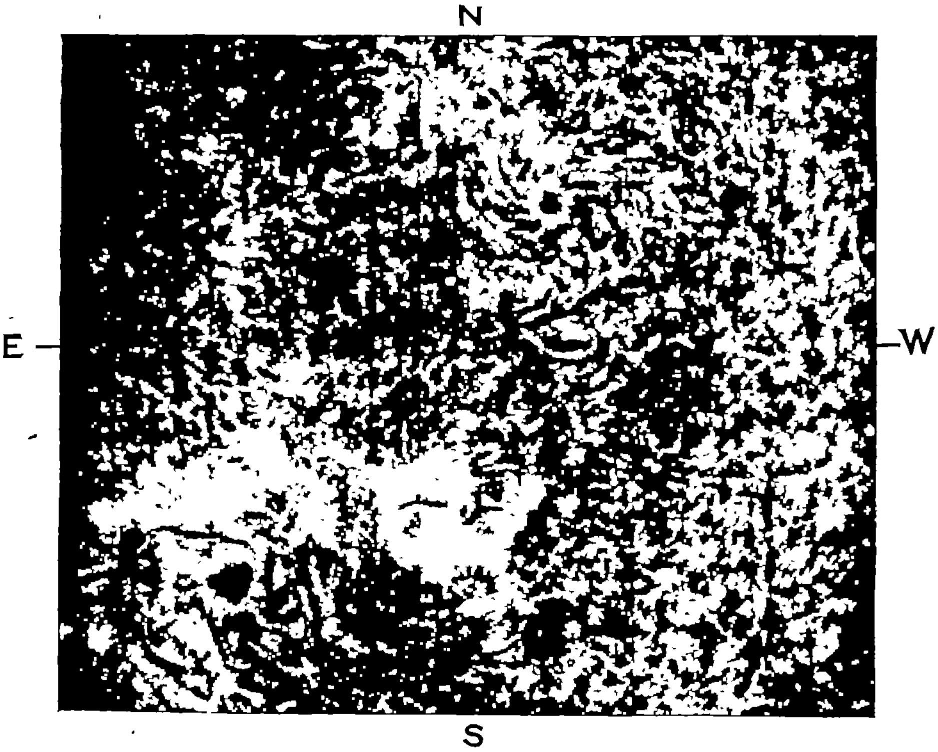

FIG. 2.—Hydrogen whirls surrounding single spots in the northern and southern hemispheres, July 21, 1919.

The directions of whirl in the northern and southern hemispheres are counter-clockwise and clockwise respectively. The northern spot is of north polarity and the southern spot is of south polarity.

I have since made a more critical examination of this question, excluding members of bipolar spots and other cases of low weight included in the above summary, and adding a number of other cases of high weight. Limiting the results to single spots, which are usually more trustworthy than the preceding members of bipolar groups, we have:

No. of spots.	Polarity.	Direction of whirl.
11	N	Clockwise.
14	N	Counter-clockwise.
12	S	Clockwise.
6	S	Counter-clockwise.

These results seem to prove beyond doubt that the direction of whirl at the level of the hydrogen flocculi is not determined by the magnetic polarity of the underlying spots. Apparently, however, it is determined by the hemisphere, as 83 per cent. of all these whirls are counter-clockwise in the northern hemisphere and clockwise in the southern hemisphere. The significance of this correspondence with the terrestrial law of cyclonic storms seems to be greatly enhanced by the fact that hydrogen whirls, which are distributed over two successive 11¼ year cycles, show no indications of reversal in direction following the sunspot minimum, corresponding to the reversal of the magnetic polarity of the spots that occurs in each hemisphere at this epoch (Figs. 2 and 7).

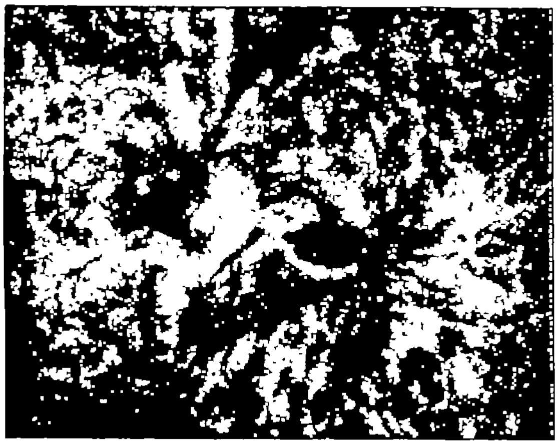

FIG. 3—Spectroheliogram showing hydrogen whirls surrounding the spots of the southern bipolar group of Aug 15, 1926. Both are clockwise and both showed inflow, as illustrated for the preceding spot in Fig 4.

TESTS WITH THE SPECTROHELIOSCOPE.

Mount Wilson spectroheliograms taken during the present spot cycle, so far as I have examined them, are in harmony with the above results Before reaching a final conclusion, however, it seemed advisable to make an independent test of the whole question with the spectrohelioscope, especially in view of the apparently serious difficulty presented by the fields of force of the bar-magnet type which so often characterise bipolar spots.

On account of my inability to make daily observations, and the necessity of devoting much of my attention to the various new phenomena revealed by the spectrohelioscope, the number of whirls included in this visual test is not large. Counting all cases, we find 14 (78 per cent.) in harmony with the terrestrial law and 4 opposed. All of the exceptions were associated with members of bipolar spots. Retaining only the single spots and the members of bipolar spots of highest weight, there remain 6 whirls (75 per cent.) agreeing in direction with terrestrial cyclones and 2 of the opposite sign.

In making these tests the spectrohelioscope offers some great advantages On spectroheliograms the direction of whirl is generally inferred from the form of the hydrogen flocculi, on the assumptio that the flow is spirally inward. As a rule, a serie of photographs taken in quick succession does no help materially, because the critical moments a which large flocculi are drawn into the whirl ar infrequent, and thus are usually missed if visua observations cannot be made for guidance. A long intervals, however, a series of photograph thus taken blindly may chance to record a grea inflow of hydrogen, like that illustrated in my firs article on "Solar Vortices" in 1908.[4] No case a all comparable with this in scale occurs among ou thousands of photographs taken since that time Similarly, we have few satisfactory records showin definite outflow. In examining a single photo graph, or a series of photographs taken unde customary conditions, we may therefore be left i doubt whether the flocculi really indicate inflow o outflow.

With the spectrohelioscope, however, there i much less room for doubt. In the course of m visual observations with this instrument I hav repeatedly seen intensely black hydrogen flocculi sometimes of great size, suddenly develop nea active spots. When first formed, these are usuall found to be rising at high velocity from region marked by bright hydrogen flocculi, and if near th centre of the sun they may completely escap detection by the spectroheliograph unless they giv an Hα line sufficiently wide to overlap the secon slit (supposed to be set at the centre of the un displaced line). They are easily picked up wit the spectrohelioscope by the aid of the line-shifter— a plane parallel glass plate in front of the oscillatin second slit, which can be rotated so as to displac the Hα line toward red or violet while observation are in progress. The divided circle on which thi glass plate is mounted affords a quick and eas means of measuring the radial velocity of an portion of a hydrogen flocculus. At the beginnin of a set of observations the second slit is adjuste so as to coincide with the centre of Hα when th glass plate is parallel to the plane of the slit an thus produces no displacement. This gives th zero of the circle. To measure the radial velocit

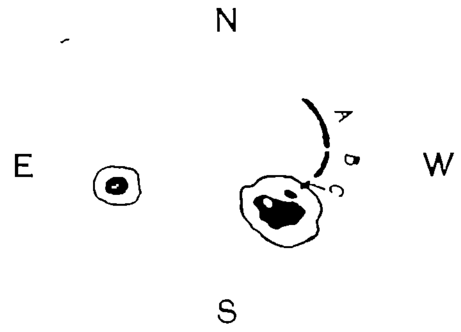

FIG 4—A new effect of inflow. Rapid acceleration in the radı velocity of the inflowing hydrogen is shown by the change ı appearance of the flocculus from A through B to C when observe with light of increasing wave-length.

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[4] *Contributions from the Mount Wilson Observatory*, No. 26; *Astı physical Journal*, 28, 100; 1908.

he glass plate is turned so as to move Hα toward the red, and several readings of the circle are made t the point where a bright or dark flocculus just egins to become visible against the background lue to the continuous spectrum. This gives the wave-length (after calibration of the circle) of the violet edge of the bright or dark Hα line in this part of the flocculus. A similar series of settings on the other side of the zero gives the wave-length of the red edge of the line, and half their sum (if the intensity curve is symmetrical) gives the centre of the displaced line, which may differ by an Ångström or more from the centre of Hα. A quicker but somewhat less accurate method is to take several readings of the circle corresponding to the position of estimated maximum intensity of the flocculus (centre of the displaced line).

In exploring the hydrogen atmosphere around a sunspot the observer keeps this line-shifter in constant use, turning well to the red and violet in order to detect rapidly moving objects. When such are found, he may observe and record the quick changes in form and radial velocity which make these observations so fascinating. Evidently we have in this simple device a certain means of determining not only the direction of whirl but also the varying radial velocity of a flocculus as it is swept toward a spot.

A NEW EFFECT OF INFLOW.

The spectroheliosope thus offers two distinct methods of distinguishing between inflow and outflow: (1) By watching the approach of a flocculus toward a spot, as in the photographic record of 1908 just cited; and (2), when no such phenomenon is in progress, by utilising a beautiful effect first clearly recognised on Aug. 15, 1926—the progressive advance toward a spot of the maximum of intensity of a curved flocculus when the wave-length of the light entering the second slit is increased by rotating the line-shifter.

The spot in question was the preceding member of a bipolar group (Mt. Wilson, No. 2656) at 18° south latitude, then about 4° east of the central meridian. This spot was of north magnetic polarity, strength of field 2800 gausses; the following spot was of south polarity, with a field-strength of 2500 gausses. The beautiful details of the Hα field of force surrounding the group (Fig. 3) were clearly seen, and one of them, the curved flocculus shown in the sketch (Fig. 4), which was more intense than the others in the same region, was selected for observation. When the circle of the line-shifter indicated a radial velocity of +22 km. per second, only the outer part of the flocculus (A in Fig. 4) was visible. As the line was displaced farther to the violet, the flocculus seemed to move from A to B, the portion B corresponding to a velocity of +45 km. per second. When the second slit was about 1·1 Ångströms to the red of the centre of Hα, corresponding to a velocity of about +50 km. per second, nothing remained visible of the flocculus except the black dot C on the edge of the penumbra. At still greater displacements the dot faded away and finally disappeared. The apparent advance of the flocculus toward the spot and the disappearance of all but the head were observed as often as the Hα line was moved across the second slit from violet toward red.

It is interesting to note the accelerating radial velocities indicated by the successive slit positions, increasing from 22 km. per second at a distance of 56,000 km. from the centre of the spot (A) to 45 km. per second at a distance of 36,000 km. (B) to about 50 km. per second for a distance of 20,000 km., corresponding to the dot marking the inner extremity of the flocculus on the outer edge of the penumbra (C). These values are not of the highest precision, but they cannot be far from the truth.

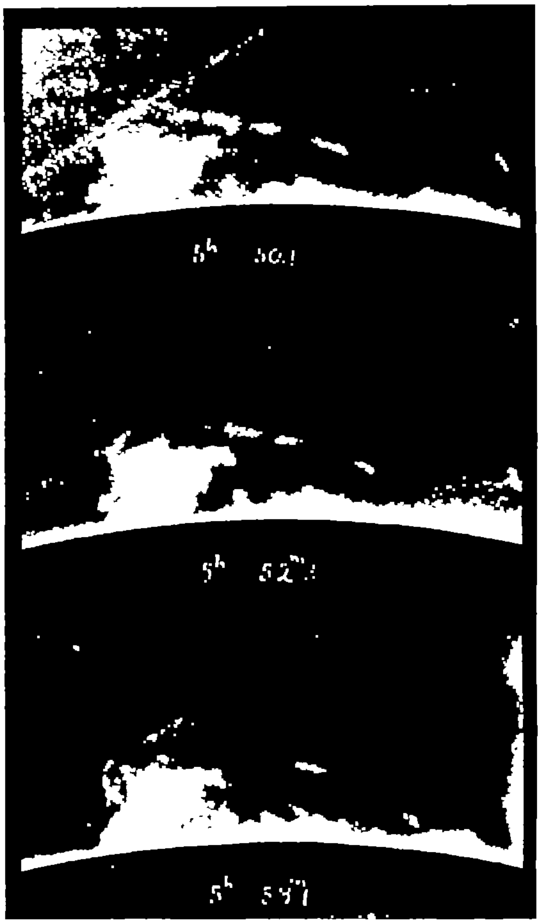

FIG. 5—Slocum's photographs of the prominence of Oct. 22, 1910, showing inflow toward the spot at accelerating velocities.

We at once recall the flow of prominences into sunspots,[5] as photographed in elevation at the sun's limb by Slocum with the Rumford spectroheliograph (Fig. 5). Another series of calcium spectroheliograms of the prominences surrounding a large spot at the sun's limb on Oct. 8, 1910, is also reproduced in his article on "The Attraction of Sunspots for Prominences."[6] Slocum directs attention to three bright knots on a long streamer, which gave velocities along the apparent trajectory of 16 km., 20 km., and 60 km. per second, at distances of 170,000 km., 130,000 km., and 75,000 km. from the centre of attraction. Pettit, who re-measured these plates, got velocities of 5 km., 8 km., and 44 km. per second respectively. From these and other measures Pettit concludes: "Normally the matter about the spot is moving into it with accelerated velocities averaging about 35 km. per second, sometimes reaching 100 km. per second." Both Slocum and Pettit found that jets may be projected away from a spot at similar velocities, but Pettit[7] does not consider them to represent the normal condition. Evershed, on the contrary, in discussing his Kodaikanal observations of prominences, says: "No case has been found in which prominences were falling into sunspots, but the reverse has several times been observed."[8] The difficulties involved are sufficiently indicated by these differences in opinion among experienced observers, but fortunately most of these are removed by the spectroheliscope, in so far as the determination of the direction of flow and the radial velocity are concerned

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[5] It should be clearly understood, however, that Fig 5 represents three successive stages in the inflow of the tip of a prominence, whereas in the case illustrated in Fig 4 the tip had already reached a point above the edge of the penumbra before the observations were begun. With a rather wide second slit, nearly the whole length of this curved flocculus (*A* to *C*) could be recorded in a single photograph, as shown in Fig 3.

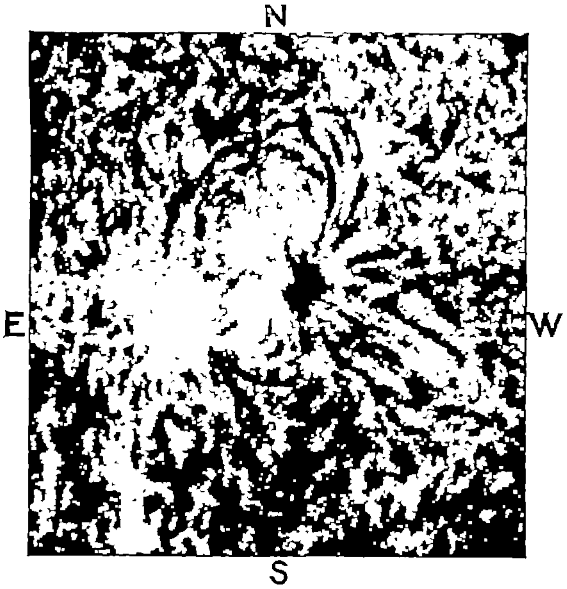

FIG 6—Single northern spot of July 9, 1919, connected with following eruptive centre by hydrogen flocculi resembling field of force shown by magnetic poles of opposite polarity. (Compare also Fig 1)

It is evident, however, that the observed radial velocity must depend upon the velocity along the true trajectory and the angle between this trajectory and the line of sight. If the trajectory is parallel to the solar surface, and the spot, as in the present case, is near the centre of the sun, there will be no displacement of $H\alpha$, and the entire flocculus will be visible when the second slit of the spectrohelioscope is set on the centre of the line.

Judging from the characteristic forms of prominences at the sun's limb, this is usually the condition of affairs at a considerable distance from a spot, though it often happens that at such a point the hydrogen is rising rapidly from below, thus producing a marked displacement of $H\alpha$ toward the violet when observed near the centre of the sun. Nearer the spot, as the prominences at the limb discussed by Slocum and Pettit indicate, the trajectory makes an angle with the sun's surface ranging from small values up to 45° or even more. At the limb, the projection of the trajectory is usually nearly a straight line over a great part of its length, and the increase in the radial component of the velocity observed on the disc as the spot is approached is doubtless due chiefly to the acceleration found by Slocum and Pettit. Sometimes, however, their limb photographs show that the tip of the inflowing prominence turns down close to the spot, and in spectrohelioscope observations made near the centre of the disc, this might account in such cases for an increase in the radial component of the velocity at this point, without a corresponding increase in the acceleration along the trajectory.

The curved flocculus shown in Fig. 4 probably represents a prominence of moderate height. If we assume the trajectory to make an angle of 30° with the sun's surface, the corresponding velocities along the trajectory would be 44 km. per second for the outer part of the flocculus (A), 90 km. for the central part (B), and about 100 km. for the tip (C).

The observation of Aug. 15 proved to be typical, and it has been repeated in scores of cases, many of which will be described in detail in the *Astrophysical Journal*, where the bearing of these results on the work of St. John, Evershed, Fényi, Slocum, Pettit, and others will be discussed. In the present article I wish merely to point out this method of observation, in which the visibility of an object emitting approximately monochromatic light depends upon its radial velocity. The method evidently affords a valuable means of analysis, not merely of the hydrogen whirls but also of other important phenomena of the solar atmosphere. Among these are the fields of force of the bar-magnet type so often found in association with bipolar sunspots.

FIELDS OF FORCE SURROUNDING BIPOLAR SPOTS.

In the typical bipolar group the component spots, single or multiple, which form the preceding and following members are of opposite magnetic polarity.[9] If the group consists of two nearly equal spots, of opposite polarity, the magnetic field of force surrounding the group should resemble the field surrounding two opposite magnetic poles. The question before us is whether the observed structure of the hydrogen flocculi, at a considerable height above the sunspot level, actually represents such an electromagnetic field as Störmer's theory would indicate.

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[6] *Astrophysical Journal*, 36, 265, 1912

[7] "The Forms and Motions of the Solar Prominences," *Pub. Yerkes Observatory*, 3 part 4; 1925.

[8] *Memoirs Kodaikanal Observatory*, 1, part 2; 106.

[9] See Hale and Nicholson, "The Law of Sunspot Polarity," *Contributions from the Mount Wilson Observatory*, No. 300, *Astrophysical Journal*, 62, 270, 1925

We have seen that the evidence offered by the fields of force associated with single (unipolar) spots does not support the theory, and a glance at the bipolar group of Aug. 15, 1926 (Fig. 3), shows a similar lack of agreement. The hydrogen whirls surrounding the preceding and following spots were examined visually by the method just described, and a definite inflow was repeatedly seen. This agreed with the spectroheliograms in showing the direction of whirl to be clockwise about both spots, in spite of their opposite polarity. Moreover, on Aug. 16 a long, slender, dark flocculus, which had apparently risen from a bright flocculus south of the group, was found to indicate inflow toward the eastern extremity of the preceding spot along a trajectory lying nearly at right angles to the lines of force. Many similar cases in apparent contradiction with the theory might be cited.

On the other hand, structure like that shown in Fig. 1 is so common that it may almost be called typical. In such cases the Hα flocculi surrounding a bipolar group strongly suggest the lines of force about two opposite magnetic poles. What evidence bearing on the nature of this structure is afforded by the spectrohelioscope?

On May 31, 1926, while observing spot No. 2571 (8° S., 20° E.) with the spectrohelioscope, I noticed a curious dark arch following the spot. The preceding end of this arch, which was seen when the second slit was on the violet side of Hα, seemed to rise from a small bright flocculus a short distance east of the spot. The central part of the arch, farther to the east, appeared when the slit was near the centre of Hα, but its eastern extremity, where it seemed to curve back toward the surface of the sun, did not become visible until the slit was well beyond the boundary of Hα toward the red. Obviously we have here a dark arched prominence, rising with high velocity from a bright source near the sunspot, pursuing a curved trajectory, the central part of which was nearly normal to the line of sight, and falling with high velocity at a point well to the east of its origin.

Since that date I have observed many of these arches. In a bipolar spot group three or four may often be seen at once, rising from a region of bright flocculi and falling at a distance, sometimes on the penumbra of one of the spots, sometimes elsewhere. When the velocities are high and the oscillating slits narrow, only a short section of an arch may be visible at a given position of the second slit on Hα. To show the whole arch, the line-shifter must be employed. As the line moves across the slit from violet to red, the maximum of intensity may be seen rising from the source of the ascending branch, passing along the trajectory, and running down the descending branch, which often seems to terminate in a rather definite dark head. The effect is of course different in different parts of the sun, because it depends upon the angle between the true trajectory and the line of sight. In general, it is best observed in the central part of the disc, but I have frequently used the method with good success near the limb.

These applications of the spectrohelioscope will serve to illustrate its advantages over the spectroheliograph when rapidly moving objects are under examination. Although I long ago recognised certain arches among the Hα flocculi on spectroheliograms, and made a study of them by stereoscopic and other means in 1925, I could only suppose, but not prove, that the bar magnet structure might be due in part to them. In this study I made use of a series of spectroheliograms taken with the second slit set on the red and violet sides of Hα, and inferred that their differences might be caused by motion of the gas along the arch. More can be learned in a few minutes, however, from such visual observations as I have just cited than from the comparison of many spectroheliograms, unless these are made with the spectrohelioscope as a guide.

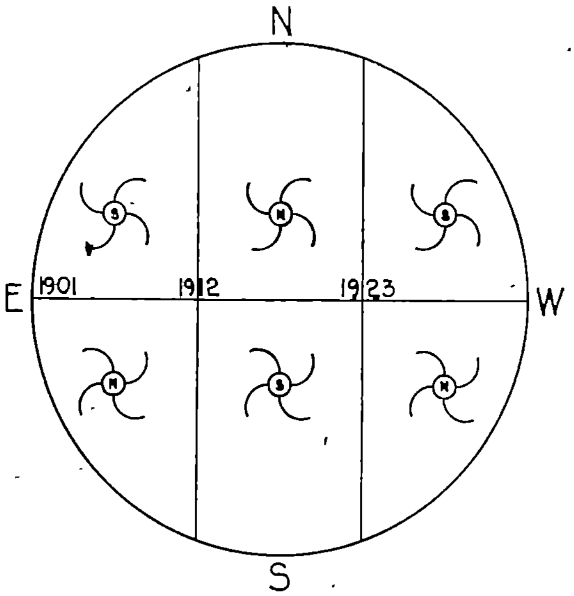

FIG. 7.—Law of single gyrating storms at two levels in the sun. About 80 per cent. of the high-level hydrogen whirls, in all sunspot cycles, are counter-clockwise in the northern hemisphere and clockwise in the southern hemisphere. The underlying sunspot vortices, as inferred from the polarities of their magnetic fields, indicate opposite directions of whirl in the northern and southern hemispheres, and periodic reversal in direction of whirl at successive sunspot minima.

My spectrohelioscope and spectroheliograph are now being arranged for simultaneous use, so that I hope soon to have photographic records of the various types of phenomena described in this paper.

If groups of arched prominences originating in eruptive centres near the spots of a bipolar group are competent to account for the structure resembling the lines of force of a bar magnet, we might expect to encounter occasional indications of this structure between spots of the same polarity and also near single spots, *i.e.* where only one of the magnetic poles is present. I have found cases of both kinds on our spectroheliograms, one of which is illustrated in Fig. 6. The new evidence therefore seems to be strongly against the electromagnetic explanation, because of the phenomena exhibited by the inflowing gas and the apparent failure of the flocculi to coincide with the lines of force surrounding single spots, between pairs of spots of the same polarity, or between the members of bipolar groups, where they often diverge, not from the magnetic poles (*i.e.* the spots themselves) but from bright eruptive centres at some distance from them. Nevertheless, as I shall show later, there still exist several difficulties in the way of accepting a purely hydrodynamical explanation of the structure accompanying single and double spots, and I am therefore reserving judgment until further studies can be made.

Whatever the results of these studies may be, I have already shown that many single spots are surrounded by hydrogen whirls, about 80 per cent. of which correspond in direction with terrestrial cyclones. We may therefore formulate an empirical law defining the direction of whirl of single gyrating solar storms (Fig. 7). For the high-level whirls shown by the hydrogen flocculi, this corresponds in all sunspot cycles to the terrestrial law, counter-clockwise in the northern hemisphere and clockwise in the southern hemisphere. For the underlying vortices which constitute sunspots the actual direction of whirl is not known, but we may safely infer from the resultant magnetic polarity of the spots that it is opposite in the northern and southern hemispheres and that it reverses at each sunspot minimum. In Fig. 7 the whirls represent the hydrogen flocculi and the letters N and S the magnetic polarities of the underlying spots in three successive cycles. A general law probably cannot be formulated for the hydrogen whirls above bipolar spots, but for the bipolar spots themselves the law has been given in a previous article.[10]

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[10] "Sunspots as Magnets and the Periodic Reversal of their Polarity," NATURE, Jan. 19, 1924.

The Exhibition of the Royal Academy, 1927.

PASSING through the eleven galleries, in which 738 selected oil paintings of the year are displayed, the attention of any student of Nature is due perhaps to landscapes and other out-of-door pictures in preference to portraits, genre, or still-life, and with the critical habit that clothes the orthodox scepticism of the scientific mind, his first instinct is to point out how his colleagues of the brush and palette have failed to appreciate the shapes and colours of natural objects of their common care. It is, however, permissible to reverse the order, and taking the representations as real (wherever possible), to gather what the artists have to tell us about Nature that ought to come within the thought of our philosophy. In this year's Academy there is a fine picture of crepuscular rays with layers of cloud, "The Coming and the Going" (319), by C. Conway Plumbe, quite a good subject for a meteorological lecture.

Prominent in any exhibition of paintings are the colour of the sky and its gradation from a real blue up above, almost the cerulean blue of the poets, through a paler and still paler blue or green to a filmy, hazy white, or even dull grey, along the horizon, with or perhaps without any definite cloud in the visible sky. There are generally plenty of examples in any exhibition, and this one is no exception. In "Looking on to Antibes from Cagne, France" (162), Sir H. Hughes-Stanton gives a very good example: the same artist's picture of "Cagnes, Alpes Maritime, France" (241), is also typical, and in "Blackberries" (396), Harold Harvey has the gradation even too well marked. "The River Mill" (14), by Arnesby Brown, is also good. With less definite colour, "Shadow and Shine, Lake-end, Ullswater" (268), and "Loch Morar" (140), Sir David Murray, show beautiful gradation, and "November" (274), Hughes, is good enough. If we can believe what the artists tell us, there are days and places where the nebulous whiteness covers the whole sky and the gradation is of cloudiness, from the whitening of the blue above to the leaden skies which are characteristic of the British Isles. We can find examples of that kind of nebulosity in "Grey Morning" (35), by Arthur E. Law, and "Sand Dunes on the Kentish Coast" (36), by Oliver Hall. W. L. Wyllie has the same touch in his picture "Waterloo: The Doomed Bridge" (128) and his "A Suggestion for the New Charing Cross Bridge" (139). W. W. Russell, in "Rochester: Evening" (53), also gives us an example of pervading and graduated greyness.

Artists, indeed, clearly differentiate themselves by their appreciation of detail and of colour; some see the blue and its gradation, and some apparently are more apt to see the greyness, or only paint a landscape when it is suffused with grey. The difference of habit is perhaps not all temperament. The photographic eye, which in these days ranges beyond the visible on either side, shows the same kind of discrimination. A photograph in the light of the extreme red is conspicuous for its clear definition, whereas the same landscape in ultra-violet light is hazy. An exhibition of paintings moves us to wonder whether different eyes are in some way sensitive beyond the visible range and whether some artists specialise in the infra-red, while others range themselves with the ultra-violet.

This carries us from the landscapes to the portraits, for in them we find an echo of the same kind of difference. Some portraits are meticulously detailed and not infrequently also ruddy, while others are suffused with a sort of mistiness and have a paler cast. The portraits by Orpen are conspicuous for their definition and their colour. In (723) Prof. J. A. Fleming forces a hard smile while floating in a sea of scarlet and yellow. Lavery, in like manner, has marked definition and bold colour; but Solomon J. Solomon paints The Right Rev. the Lord Bishop of Worcester (44) in the more hazy part of the spectrum and with less violent definition.

Talking about culture and civilisation, philosophers have classed art, music, literature, and the mathematics as corresponding expressions of human genius and, like the rest of them, the artist expresses by his treatment not merely his subject but also himself. His true aim is not a perfect autochrome but something that through the material displays the divinity that shapes his ends and ours. His claim that he can paint only what he sees must be set aside. Through the pictures we can obtain a sort of line spectrum of the artist. There is a good deal of interest in carrying that idea with one through the Academy exhibition. Of course the artist is not everything; the sitter as the medium of expression counts for something. It is clear from the exhibition that men are mostly clothes, sometimes little else, and women, with here and there an exception, are jewel stands. Clerics have a strong vein of pessimism, with the exception of the Bishop of Worcester; 'dons' are complacently resigned; politics, commerce, and industry are built up round an artificial smile; and marquesses are sly—very sly. But in spite of these intrusions into the natural spectrum we have to ask ourselves what are the lines belonging to the artist. For Orpen there is a strong line of realism and humanity towards the infra-red; he even goes so far as pinning down the unavoidable humanity of Miss Penelope Lawrence, M.D. (143), though he excuses women more easily than men. So does Sir John Lavery. Outside humanity there are not many lines in Orpen's spectrum. We can find more in Jack's picture of H.M. The Queen (133), and still more in his "The Blue Drawing-Room, Buckingham Palace" (103). There is something, too, in La Thangue's "Tying Watercress" (255) and Mrs. Dod Procter's "Morning" (735). W. W. Russell's spectrum is so nearly continuous that he seems to be waiting for a reincarnation either of himself or his sitters to suggest a relation of life's enigmas.

If a crowd round a picture at the private view is any clue to its greatness, "Paolo and Francesca" (179), by F. Cadogan Cowper, seemed to be the favourite, and certainly it is an impressive scheme of colour; but still more on the side of the mystery of divinity is "The Enchanted Road" (350), by F. O. Salisbury, or "Svilata, Avati and Augali Sen, Daughters of Mr. and Mrs. Rimsod Sen" (652), by the same artist, and Clausen's "The Nut-brown Maid" (566). The mystery is not confined to portraits; it is quite impressive in "Theatre Marcellus" (75), by Sydney Lee, though the picture belongs to the red end of the artistic spectrum. But spectrum analysis of character is a perplexing study. Those who visit the Academy may take with them their own instruments. "Quai des Grands Augustins, Paris" (86), by Charles Cundall, is good for demonstration.

Obituary.

Prof. E. H. Starling, C.M.G., F.R.S.

A FEW days ago news was telegraphed from Jamaica that Prof. Ernest Starling died on board the *Ariguaing* shortly before reaching Kingston. Of late years he had had indifferent health and had suffered from disabilities under which one of less heroic spirit could not have continued to work strenuously. His enthusiasm for the discovery of new truths was unimpaired, and his mind was so sympathetic and alert that it was difficult to believe he was not a sound man. Nevertheless, evidences of diminishing capacity for work without undue fatigue were obvious to his friends and a source of anxiety to them.

At the close of the winter session, during which he had been daily occupied with arduous experiments, he was very tired. The weather was cold and dull, and he longed for sunshine and warmth. He therefore decided to take a voyage to the West Indies, in full hope that this would restore his energies and enable him to continue with enjoyment the experimental work with which he was occupied. However, that was not to be, but he had the satisfaction of going down with his flag flying, as he would surely have desired.

Ernest Henry Starling was born in 1866. His father, H. H. Starling, was Clerk of the Crown at Bombay. The family of seven children had perforce to be educated in England. They therefore saw but little of their father and were brought up by their mother, an extraordinary woman, and it is to her influence by heredity and nurture that Starling owed his determination, mental alertness, and much of his charm. As the eldest boy, in the absence of a father he early acquired a sense of responsibility and capacity for managing his affairs, and was, in some respects, unusually mature for his years. He was educated at King's College School. He left at 16½ years of age, having matriculated at the University of London with honours, and proceeded to the study of medicine. He chose Guy's Hospital because his uncle was a Guy's man.

At this time Starling's ambition was to be a physician and live in Harley Street, and it was not until a few years later that he began to doubt the all-sufficiency of this ideal and to contemplate the possibility that he might be able to devote himself to an academic career and perhaps become a discoverer himself. As soon as he touched the study of natural science it was clear that Starling had found his *métier*. The causal relation of facts enthralled him. He was intensely curious, and had a naturally scientific mind. He was gifted with fine intellectual machinery, a good memory, industry, and possessed great powers for work, and it was soon clear to his teachers that they had a very exceptional pupil. The teachers of natural science at Guy's in those days were men of distinction, but they only called for a few hours weekly to deliver their lectures. The one who made a great impression upon Starling was Dr. Debus, of the Royal Military Academy, Woolwich, who gave part of the lectures on chemistry. He was a fine teacher, and the enthusiasm with which he expounded the elements of chemistry was infectious.

At the examination in preliminary scientific subjects at the University, Starling obtained the first place in chemistry and botany and second place in physics. He obtained so many medals and prizes as he proceeded through his medical course that an account of these academic victories at university and hospital would be wearisome. About two-thirds of the academic honours available were secured by him, including a free studentship at Guy's Hospital. These various college and university scholarships sufficed to maintain him, and if he had liquidated the many gold medals awarded to him he would have been able to enjoy comparative affluence.

Physics and chemistry attracted him and the generalisation of biology, but it was when Starling came to study physiology that he met his fate. It cannot be said that his affection for physiology was due to his teaching at the Hospital. It was largely his own discovery, but Foster's text-book made a great impression upon him. After two years' study of physiology, during which he read many original papers, including all the back numbers of the *Journal of Physiology*, he had determined, I think, to become a physiologist, if such a career was economically possible. He had felt the deprivation due to his inadequate knowledge of German, so, after disposing of his second technical examination in 1886, he went, largely with the idea of improving his German, for a few months to Heidelberg, and worked in Kuhne's laboratory. He returned at the end of the year with his hair *en brosse*, much teutonised, and more than ever determined to become a physiologist, However, he had to put these aspirations aside for a while and devote himself to the study of practical medicine. This he did with his usual enthusiasm. Starling found great satisfaction and enjoyment in clinical work. The human side appealed to his sympathetic nature and the immediate value of the application of knowledge to his practical mind. If it had been possible to devote himself whole-heartedly to the study of medicine, as is now possible by the institution of full-time professorships, Starling would have been as happy investigating disease as in a physiological laboratory. Indeed, not many years ago he seriously considered accepting such a position.

Having completed his medical studies and occupied the position of house physician and house surgeon at the hospital and graduated M.D., Starling was confronted with the problem, how he was to live if he were to follow his desire and devote his life to physiology. With his brilliant career at the hospital, the profession of a physician was open to him and success undoubted. He was keenly interested in medicine and pathology, and the temptation to follow the line of less resistance and greater promise of reward was considerable. However, in 1889 he determined to try the rougher path, and became demonstrator in physiology. The rewards of this office were minute, and Starling told me that he owed the possibility of giving his allegiance to science to a British Medical Association Scholarship for medical research. The Scholarship was worth £150 a year, and this addition to his slender salary kept him going. Next year, owing to the death of Wooldridge, a vacancy as joint lecturer on physiology occurred and Starling was appointed. On the termination of the British Medical Association Scholarship he was appointed to the research scholarship of the Grocers' Company of the value of £250 per annum. It was not then so easy to embark on a scientific career without financial resources as it is now, and it is terrible to think how one of Starling's glorious attainments was nearly deterred.

He was confronted, not only with the problem of how he was to continue to subsist on one-third of a salary which was never intended to command the whole services of a physiologist, but also how he was to secure a physiological laboratory to work and teach in. The Grocers' scholarship temporarily solved the first problem, and he determined that adequate accommodation and equipment for teaching and research in physiology should ere long, by some means, be obtained. Meanwhile, being but one of three joint lecturers, he was able to arrange to go and work abroad occasionally. In 1893 he went to Breslau to work with Heidenhain, and later for a few months to the Pasteur Institute, as he was greatly impressed by Metchnikoff's discoveries about phagocytosis. In order that this work might be more available to English students, he and his wife translated Metchnikoff's lectures on comparative inflammation.

Until his hopes for a physiological laboratory should materialise, Starling did his best to secure some improvement of the arrangements for practical teaching and demonstration with the funds available, meanwhile he repaired to Schafer's laboratory at University College to carry on his researches. Bayliss was also working in the laboratory, and here began a scientific partnership which lasted on and off for thirty years. The two complemented one another in many respects. Whilst both possessed scientific imagination of the highest order, Starling was more ardent and forceful, eager to translate ideas into action, but rather bored with details of technical method. He had never been interested in doing things with his hands, except climbing, although later he became a most beautiful and dexterous operator. Bayliss was the philosophical student, calm, with better critical judgment. He read widely and had a wonderful knowledge of scientific literature, was an excellent mechanic, and found enjoyment in the development of the technical methods of research. How fruitful this partnership was will be seen from the account below of Starling's scientific work.

The equipment at Guy's Hospital steadily improved, and Starling and Bayliss did their work on the innervation of the heart there. By 1895 Starling had planned a really good physiological institute for Guy's Hospital, and secured the assent of the authorities to its erection. These laboratories were completed in 1897 and were, at that time, the best laboratories for physiology in London. The amount of time and effort involved in this accomplishment was considerable. Unwilling authorities had to be persuaded to provide territory and funds and colleagues to make sacrifices of their own legitimate aims, and although it was becoming recognised that Starling was going to be a great man and was an ornament to the staff, this was no easy matter.

Not long after the opening of the new physiological laboratories at Guy's Hospital, the Jodrell chair of physiology at University College fell vacant owing to Schafer's acceptance of the professorship at Edinburgh. In 1899 Starling was appointed. It was a wrench to leave his fine new laboratories, to the construction of which he had devoted so much time, but the emoluments of the Jodrell chair were greater, and the conditions at University College he deemed more favourable to the realisation of his ideals. Moreover, he was determined that it should not be many years before he would have a new Institute of Physiology at University College, for the planning of which the Guy's laboratories would have served as useful exercise.

This determination came to fruition in 1909, when the present fine Institute of Physiology was opened. Starling's plan was not merely for a new physiological school, in which he was naturally more particularly interested, but he wanted all the medical sciences at University College to have the advantages of more commodious and nobler buildings. His original scheme was for an Institute of the Medical Sciences, including anatomy and pharmacology as well as physiology, with a central library, pathology being well housed in the new Clinical School. At first only the physiological section was built, but a few years ago the erection of the whole institute, as originally contemplated, was rendered possible by a generous gift from the Rockefeller Foundation, the directors of which were desirous of devoting funds in the interest of medical science in London. That they chose this particular means of fulfilling their aims was largely, if not entirely, due to Starling, and the noble Institute of Medical Sciences with which University College is now endowed is a fine material monument to the memory of one who not only helped to build up a great school of physiology in London and obtained an appropriate habitation for it, but also was as unsparing in his efforts to secure similar advantages for the other medical sciences.

In 1923 Starling retired from the Jodrell chair and was appointed to a Foulerton research professorship of the Royal Society. He still continued to work at University College, but was relieved of all administrative duties and all teaching except that of a small band of research pupils. His laboratories continued to be a centre of great activity, and a limited number of distinguished young physiologists from Great Britain and abroad still enjoyed the advantage of working in close communion with one of the greatest masters of experimental physiology. It was a happy family.

STARLING'S PHYSIOLOGICAL RESEARCHES.

"Only by following out the injunction of our great predecessor [Harvey], to search out and study the secrets of Nature by way of experiment, can we hope to attain to a comprehension of 'the wisdom of the body and the understanding of the heart,' and thereby to the mastery of disease and pain, which will enable us to relieve the burden of mankind." (Starling, Harveian Oration, Royal College of Physicians, 1923.)

Starling's interest in physiology was general, but the subjects for investigation which particularly attracted him were those physiological processes which seemed capable of interpretation in terms of chemistry and physics. Whilst realising that adaptation was the essence of organism and had no counterpart in inanimate nature, he had not much sympathy with the neo-vitalists. In his view, if the contraction of muscle was not understood, it was because we did not know enough about physics and chemistry or about muscle.

He was always, from his student days, fascinated with the problem of the heart and the adjustment of its action to varying conditions of the body, and his first paper, written with Bayliss in 1891, was on the electromotive phenomenon of the mammalian heart. Waller had recently studied the electrical variation of the excised heart and also of the heart *in situ* by leading off from the neighbourhood of the apex and base respectively. It was evident to Starling that by photographing the movements of the capillary electrometer, connected with electrodes placed in different positions on the naked heart in the anæsthetised living animal, much might be learnt of the nature of the cardiac contraction; in fact, that a new method of observation was at the disposal of the investigator. At that time, any sort of muscular continuity between the auricles and ventricles was denied, and the view that conductivity was due to some nervous network supplying the fibres was in favour. In this research he enjoyed the co-operation of Bayliss. They set out to ascertain the course and time relations of the wave of contraction in the ventricle, the nature of the transmission from auricle to ventricle and throughout the ventricle, and to examine critically Frédéricq's reasons for regarding the nature of the ventricular contraction to be tetanic.

They succeeded in showing (1) that the ventricular contraction is a single wave starting from the base; (2) that there is a natural-block at the auriculo-ventricular groove; (3) that the rate of transmission of the contraction wave is about 5 metres per second. This sounds commonplace at this time, when the electrocardiograph is in general use for clinical diagnosis, but their observations not only formed an important step in the development of our knowledge of cardiac contraction and in the interpretation of disease of the heart, but also, by showing what valuable information could be obtained by the electrical method, stimulated its employment and accelerated the development of the electrocardiograph.

They next explored the separate action of the vagi and accelerator nerves on the auricles, on the ventricles, and on the conducting power of the auriculo-ventricular junction in the mammal. The effects of these nerves on the hearts of frogs and tortoise had been previously studied by Gaskell and Heidenhain, and that of the vagi upon the auricle of mammals. Bayliss and Starling completed the story, showing that there was no essential difference between the hearts of mammals and cold-blooded animals, and that the vagus depresses conduction in auricle, auriculo-ventricular junction and ventricle, and that the accelerator nerves had the opposite effects on all three structures.

Two other important papers dealing with the mechanism of the circulation were published by Bayliss and Starling at this time. One was an exhaustive study of the simultaneous changes in the arterial and venous pressures of various regions of the body under a great variety of experimental conditions. The results showed the universal applicability of the principle of the circulation worked out by Ludwig. They said, in their paper, that the effects produced were such as might have been predicted by any one with a knowledge of the elementary principles of the circulation. However, nobody had predicted them.

The last contribution of this first series of papers on the circulation was an analysis of simultaneous pressures in the aorta and ventricles of the heart *in situ*, by an ingenious method which was a vast improvement on any hitherto devised. They used a continuous photographic record of the changes in volume of a small air-space at the end of a capillary glass tube connected with the aorta and ventricle respectively. This method was free from inertia and aperiodic. and they succeeded in obtaining a true record of the rapid variations occurring in the ventricle and aorta and the precise relation of these to one another. Their measurements have been the standard of reference ever since.

TRANSUDATION FROM THE VESSELS AND LYMPH-FLOW.

In 1892, Starling, for a while, relinquished the study of the blood circulation and turned his attention to the mechanism of lymph flow. The conditions determining the equilibrium between the liquids in the blood-vessels and tissue spaces required exploration. Was lymph a transudation or an excretion ? Heidenhain had recently published a stimulating paper on lymph formation, in which he concluded that normally filtration played no part in the formation of lymph, so in 1892 Starling went to work in the Breslau laboratory.

Heidenhain had distinguished two kinds of lymphagogues, and under his inspiration Starling set to work to make a more detailed analysis of the effects of one of them, peptone. In summarising his results he adopted the interpretation of Heidenhain that the experimental facts concerning lymph formation could not be explained by filtration and that it was necessary to suppose a selective activity on the vessel wall. However, on returning to England he continued to work energetically at the problem of lymph formation and repeated all of Heidenhain's experiments. He was able to confirm his facts but came to doubt the correctness of his interpretation. He searched for evidence of lymph-secretory nerves, but found that the nervous system could only influence lymph flow by altering vascular conditions. After years of experimenting he came to the conclusion that it was unnecessary to suppose a secretory activity of the endothelium, and that there was no experimental fact inconsistent with the view that lymph formation was a function of two factors, permeability of the vessel wall and intracapillary pressure. Nevertheless, there were a number of observations equally unintelligible on either hypothesis, and further work with Leathes and Tubby on the absorption of various solutions from the pleural cavities only emphasised that there was yet another factor concerned in determining whether fluid passed in or out of the capillaries.

In 1896 Starling discovered that the missing factor required to afford a complete interpretation of the phenomena was the osmotic pressure of the colloids, to which the walls of the capillaries are relatively impermeable. It had hitherto been supposed that the osmotic pressures of proteins, being so insignificant compared to those of salts, must be of no account in physiological processes. The reverse is indeed the case, because it is only to the proteins that the membrane is impermeable. He therefore set to work to measure the osmotic pressures of the proteins in serum and found them to be, though small, of the order of magnitude of the capillary pressure. The problem was solved. The hydrostatic pressure and the osmotic pressure supplied the balance of forces necessary to explain the experimental observations. These, together with altered permeability of the endothelium, are capable of supplying a reasonable interpretation of œdema and pleural effusion, and formed the subject of his Arris and Gale lectures to the Royal College of Surgeons in 1926.

Starling's work on lymph formation occupied five years, and is of the best he did. After long-continued and difficult experimentation, combined with observation of the highest order of accuracy, this hitherto obscure but fundamentally important region of physiology was finally illuminated by his dexterous experimentation and triumphant imagination.

THE MOVEMENTS AND INNERVATION OF THE INTESTINES.

When Bayliss and Starling undertook this study, the nerve supply to the small and large gut had been carefully determined by Langley and Anderson, but of the working of the neuromuscular mechanism there were many discrepancies as to fact and opinion. After eighteen months' careful experimenting, with appropriate recording methods devised for the purpose, they were able to reduce the previous chaos to order and to summarise the main facts concerning intestinal movements in a few simple statements. (1) That peristaltic contractions are true co-ordinate reflexes carried out by the local nervous mechanism and independent of the connexion with the central nervous system. (2) Local stimulation of the gut produces excitation above, inhibition below. (3) Besides the local mechanism, every part of the gut is subject to the control of the central nervous system through the splanchnics and vagi, the former being inhibitory and the latter containing both augmenting and inhibitory fibres. This was as far as understanding of the matter progressed until Cannon introduced the method of observation by means of X-rays in an animal fed upon a bismuth meal.

PANCREATIC SECRETION.

The discoveries of Pawlow had determined the order of events in gastric secretion and their co-ordination through the agency of the nervous system, but although he had found that no secretion from the pancreas occurred until the acid chyme reached the duodenum, just how pancreatic secretion was called forth in an appropriate manner had baffled this great experimenter and his pupils. Popielski had determined that the. introduction of acid into the upper part of the small intestine caused secretion from the pancreas, notwithstanding previous section of the vagi and sympathetic or even complete extirpation of the solar plexus. He concluded, therefore, that secretion must be brought about reflexly, by means of some local nervous apparatus.

Bayliss and Starling started their investigations with the idea of deciding where this peripheral nervous mechanism was. They verified all the facts stated by the Russian physiologists but were unsuccessful in proving the existence of any nervous mechanism controlling pancreatic secretion. Nor could they discover how secretion was brought about until they made the crucial experiment which led to the discovery of secretin.

I happened to be present at their discovery. In an anæsthetised dog, a loop of jejunum was tied at both ends and the nerves supplying it dissected out and divided so that it was connected with the rest of the body only by its blood-vessels. On the introduction of some weak hydrochloric acid into the duodenum, secretion from the pancreas occurred and continued for some minutes. After this had subsided, a few cubic centimetres of acid were introduced into the enervated loop of jejunum. To our surprise, a similarly marked secretion was produced. I remember Starling saying, "Then it must be a chemical reflex."

Rapidly cutting off a further piece of jejunum, he rubbed its mucous membrane with sand in weak hydrochloric acid, filtered and injected it into the jugular vein of the animal. After a few moments, the pancreas responded by a much greater secretion than had occurred before. It was a great afternoon.

Bayliss and Starling followed up their discovery in many important directions which space forbids me to mention. A method of obtaining natural pancreatic juice was now available, and they made full use of their opportunities to study trypsinogen and its conversion into trypsin by enterokinase. Their observations were afterwards summarised and their significance illustrated in their Croonian lecture to the Royal Society in 1904.

Starling was also moved by them to much constructive thought and further research on the chemical integration of the bodily functions generally. He proposed the name 'hormones' or chemical messengers for all such active principles formed in one part of the body and distributed by the circulation to excite the normal functioning or stimulation of growth of other parts. This fascinating story, embellished with a wealth of illustration, formed the subject of his Croonian lectures to the Royal College of Physicians in 1905, entitled "The Chemical Correlation of the Functions of the Body."

RESEARCHES UPON THE ISOLATED HEART.

The behaviour of the heart had interested Starling from the time he was a house physician. His earliest work was upon the heart, and though he diverged into other fields of investigation, the questions which intrigued him at that time always retained their fascination. In 1909 he returned again to their investigation. He had been attempting to dissociate the effects of asphyxia on the circulation into those due to diminished oxygen and increased carbonic acid tension respectively. He used the 'spinal animal,' that is, one in which the brain above the pons has been destroyed. He obtained some interesting information, but the observations were difficult to interpret until he should be able to separate the effects of alteration in the gaseous composition of the blood upon the heart itself.

To arrive at this, it was necessary to be able to record the influence of variations of carbon dioxide and oxygen upon the mammalian heart isolated from the nervous system and not subjected to any simultaneous modification in its nutritive state, in the inflow of blood, or in the amount of work it was called upon to do. To satisfy these requirements the heart must be isolated from the rest of the body and at the same time fed with a constant supply of perfectly oxygenated blood; it must be working under mechanical conditions completely under the control of the experimenter. This was accomplished by a device, now famous, known as Starling's heart-lung preparation, in which the lesser circulation is intact, but the only paths from the left ventricle to the right auricle are (1) through the coronary arteries, (2) through an artificial connexion in which the resistance can be regulated. By appropriate means the pressure and flow in different parts of the circulation can be recorded and also the volume of the blood circulation per unit time and the work done by the heart. If required, the gaseous metabolism of the heart contracting under various conditions can be studied. The limited amount of blood in circulation permits analysis of its contents from time to time. Further, the method is admirably adapted to the observation of the direct effect of drugs, etc., upon the mammalian heart, working under every conceivable condition. Nor does this exhaust the possibilities of Starling's heart-lung preparation as an engine of research into cardiological problems. The flow through the coronary circulation can, if necessary, be diverted and measured so that change in the blood-supply to the cardiac muscle can be determined.

After the perfection of this technique, a series of discoveries were made by Starling and his pupils, which, in conjunction with those of Lewis, have made the laboratories of University College as famous a focus of research upon the circulation as was the laboratory of Carl Ludwig sixty years ago.

The years immediately succeeding the development of this method of studying cardiology were the most productive, from the point of view of scientific output, in Starling's career. He was surrounded by enthusiastic and devoted pupils drawn from all over the world. He had plenty of problems for them to attack, with every prospect of a reasonable reward for their efforts. Starling was unsparing in helping them towards their solution, often performing the more difficult parts of the experiments himself and afterwards writing their papers for them.

It is only possible to indicate the principal researches undertaken and the more fundamental facts established by this happy band of discoverers until it was scattered by the outbreak of war in 1914. Detailed accounts will be found in the publications from his laboratory between the years 1910 and 1915. They are in no case merely qualitative observations but quantitative determinations. They occupy hundreds of pages of the *Journal of Physiology* and other periodicals during this period. They show the marvellous power of the heart, apart from the nervous system, to adapt its work in accordance with the needs of the body as a whole, and also the exquisite mechanisms to enable it to do this within wide limits, without embarrassment or permanent injury.

In the first case the effects of variations in the tensions of oxygen and carbon dioxide in the blood upon the diastolic volume and output of the heart, on its capacity for work, and on the flow through the coronary arteries, were determined. The heart was found to have an astounding power of utilising the oxygen in the blood. When an isolated heart was fed with blood from an asphyxiated animal, the heart removed all but traces of oxygen. The conditions controlling the rate of the heart-beat were studied, and the only influences found to modify the rate of the isolated heart were temperature, the volume of the inflow, and adrenalin. The maximum output of the heart was measured and found to be three litres a minute for a dog's heart weighing 50 gm. Important observations were also made upon the energetics of the heart by determining the oxygen used per unit of work done. The respiratory quotients of the normal and diabetic heart were determined, and from these two sets of observations the efficiency of the heart as a machine working under various loads was determined. The ventricular output was discovered to be independent of the arterial pressure, but, on the other hand, it was found to be dependent upon inflow. From this it appeared that as the heart dilated and its fibres were stretched, it worked with greater efficiency. This was afterwards shown to be the case by his distinguished pupil Lovat Evans.

The experiments upon the flow of blood through the coronary arteries showed that this flow was primarily dependent upon the arterial pressure, but that dilatation of the coronary system occurred when the carbon dioxide tension in the blood increased, when adrenalin was added, and most markedly when some metabolites, the product of the heart's own activity, were added to the blood circulating. In the latter circumstances the increased flow through the coronary arteries was out of all proportion to the pressure in the aorta, a further indication of automatic adjustment to a condition of stress.

Starling having supplied us with a new method of inquiry, many competent physiologists could have ascertained much of the information outlined above, but there was one discovery which is peculiarly the product of his genius, namely, that cardiac muscle, like voluntary, contracts more forcibly as it is stretched even up to the point when the texture is fractured. Therefore to work at greatest efficiency a heart must first dilate, which it inevitably does, as the pressure in front of it increases. This is what Starling calls the "Law of the Heart." As he said in the fine Harveian oration he delivered before the Royal College of Physicians in 1923, when he expounded in simple and beautiful language the results of his researches into the movements of the heart, "The heart has thus the power of automatically increasing the energy evolved at each contraction in proportion to the mechanical demands made upon it, behaving in this way almost like a sentient, intelligent creature."

Starling's Services during the War.

After War broke out Starling became very unsettled. He wanted to go and fight. Persuaded, if not convinced, that this was not the most suitable manner in which to satisfy his strong tribal instincts, he joined the R.A.M.C. as a Captain and was for some time a medical officer at the Herbert Hospital. Later, as the scientific resources of the country were mobilised, he was made Director of Research at Milbank and was busy experimenting with defensive methods against poison gases. In this he rendered invaluable service to his country, and no one could be better to control a research laboratory. However, at the end of 1916 he was exalted to the rank of Lieut.-Colonel and sent as Chemical Adviser to Salonika, where he had nothing to do. Maybe his impatience of official methods had embarrassed the authorities. In 1917 he resigned his commission, deeming that he could be of greater service as a civilian.

At that time food-shortage seemed most likely to decide the issue, and Starling became chairman of the Royal Society Food Committee and was largely responsible for the value of the advice given by it to the Government. Afterwards he was scientific adviser to the Ministry of Food, and British scientific delegate on the Inter-Allied Food Commission.

In all these capacities Starling rendered yeoman service. He soon had a mastery of the necessary facts, and he was by nature and training able to marshal them comprehensively and arrive at definite conclusions. He was never 'havering,' and he impressed all those statesmen and officials with whom he had to deal. It is doubtful whether any other of our physiologists could have served us so well.

Later Researches on the Circulation.

For a while, after the War, Starling's work was seriously curtailed owing to ill health, which finally necessitated a serious surgical operation. However, in 1920 he was back again at work, with Anrep, on the central and reflex regulation of the circulation by an ingenious cross-circulation method built up on his heart-lung preparation. In this method the circulation through the brain of an animal is entirely under the control of the experimenter, while the animal's own heart supplies the rest of its body.

A notable discovery was that, whereas rise of aortic pressure leads to dilatation of the blood-vessels so long as the depressor nerves are intact, change in the blood-pressure in the supply to the brain produces the reverse change in the pressure of the rest of the body. These fundamental laws of vasomotor regulation were suspected but never before established.

The Secretion of Urine by the Isolated Kidney.

The heart-lung preparation affords a means by which any isolated organ may be fed with arteria blood of known composition at any desired pressure rate of flow, and temperature. It is thus possible to study the functions of an organ apart from nervous influences and from the chemical influences which may arise in consequence of modifications in the blood caused by other organs of the body. After numerous attempts, Starling and Verney succeeded in maintaining the isolated kidney in such a condition that it would secrete abundant urine.

By this method, which demands extraordinary experimental skill, Starling has opened a new chapter on the physiology of renal secretion. Already, many new facts, and others which were previously only matters of surmise, have been discovered and established. His observations with Verney and in collaboration with Eichholtz have shown that the glomeruli filter from the blood plasma its non-protein constituents, and that by using hydrocyanic acid to suspend tubular activity, a pure glomerular filtrate is obtained from the ureter. Also that, whilst urea and sulphate are secreted by the tubule cells, water, chloride, bicarbonate and glucose are re-absorbed by the tubule cells from the glomerular filtrate. Pituitrin increases the amount of chloride and decreases the amount of water eliminated.

The influence of the pituitary gland upon the secretion of the kidney was particularly studied by Starling's pupils, Eichholtz and Bruhl. Their experiments suggest that the inability of the isolated kidney to secrete inorganic phosphate is due to the absence of the pituitary hormone. If this be so, it is another discovery of a chemical correlation of the body for which Starling is largely responsible.

These researches on the isolated kidney were in full swing in April when Starling left for the holiday which was long overdue. They were affording most important results, and doubtless, had he been spared to continue them, he would, with his unrivalled experimental skill, ultimately have succeeded in clarifying our knowledge of urinary secretion as he had laid bare the principles involved in the self-adjustments of the heart to physiological requirements.

Starling as a Teacher.

Starling was a fine teacher. He had not a natural gift of oratory, but by practice he early became a good, coherent and agreeable speaker. He had a happy way of finding telling phrases to emphasise the main points of his discourse, and sometimes, when feeling deeply, he was eloquent. His enthusiasm was infectious, and his pupils enjoyed his lectures. His influence as a teacher was, however, not confined to those who had the privilege of sitting at his feet. His "Principles of Human Physiology" is the best text-book on the subject in the English language, and is widely used by students on both sides of the Atlantic. It has also been translated into Spanish. As a teacher to research students he was ideal. He loved the companionship of young men. To every one, provided only that he were a serious inquirer after truth, he was ready to extend help, encouragement and friendship.

An account of Starling's scientific career would be incomplete without allusion to the part played in it by his wife. In 1891 he married Florence Wooldridge, the daughter of Sir Edward Sieveking. They were inseparable companions. With unselfish devotion she helped him more than will ever be known. They discussed all his projects together, and for many years she performed for him all the functions of an efficient secretary. Further, in addition to the responsibilities of bringing up their four children, she bore on her shoulders the burden of the humdrum duties of his life, thus releasing the more energy for his work.

Starling was the recipient of many academic honours. Honorary degrees were conferred upon him by the Universities of Dublin, Sheffield, Cambridge, Breslau and Heidelberg. He received the Baly Medal in 1907 and the Royal Medal of the Royal Society in 1913. What place amongst the great discoverers in medical science should be allotted to Starling must be left to the judgment of posterity, but it will be generally conceded by his contemporaries that he was one of the foremost physiologists of our time, and that no one since Harvey has so greatly advanced our knowledge of the action of the heart.

Although no man gave more devoted service to science, Starling's interests were many-sided. He loved music, he loved beauty, he loved a fight; in fact, he loved life. The great charm of his companionship was, in part, due to his extraordinary mental alertness and boyish enthusiasm; like Peter Pan, he refused to grow old. His death means a sad loss to all of us and will be felt not least by the generations of pupils who have been his companions during his lifelong search for new knowledge by experiment. C. J. Martin.

News and Views.

In a supplement to Nature for July 3, 1926, Dr. G. E. Hale described his recently completed spectrohelioscope—a visual instrument for observing solar phenomena in monochromatic light—and indicated its large scope in exploring the higher parts of the sun's atmosphere. On p. 708 of our issue this week, Dr. Hale gives us some of his results obtained during the last few months from observations of the hydrogen gases involved in the upper part of the vortex of a sunspot and its attendant region of disturbance. The particular problem to which he has applied his instrument is to determine whether the characteristic appearance of whirl-formation of the hydrogen flocculi surrounding sunspots is hydrodynamical or electromagnetic in origin. These hydrogen whirls, depicted on photographs taken in monochromatic light of $H\alpha$ by the spectroheliograph, had previously been closely studied by Dr. Hale, who found the evidence inconclusive for an explanation of their exact nature, for they appeared to be unrelated to what is presumably a periodic reversal every 11½ years of the direction of whirl of a deeper-seated vortex which gives rise to the magnetic field of a sunspot. He is now able to show in the present article that his recent observations afford a more critical test, which proves to be against the electromagnetic explanation. He states, however, that there still exist several difficulties in the way of explaining the structure of the flocculi along purely hydrodynamical lines.

One great advantage of the spectrohelioscope is that it permits the observer to watch continuously the movements of the solar gases, and by means of a 'line-shifter'—a neatly devised accessory—the radial velocity of separate portions of a flocculus can readily be estimated. Although photographs of hydrogen flocculi strongly suggest movements of inflow or outflow, the reality of such motions has, as a general rule, been difficult to establish even from a long series of daily spectroheliograms or from others taken at shorter intervals. With his spectrohelioscope, Dr. Hale has now seen a number of these flocculi being drawn into spots with accelerated velocities, in one instance increasing from 22 to 50 km./sec. at corresponding distances of 56,000 km. and 20,000 km. from the centre of the spot. These and other observations of moving masses of gas in the near vicinity of spots have an important bearing on the motions of related prominences which have been recorded from time to time. The possibilities of this instrument and the remarkable observations which have already been made with it are of the greatest interest.

The commemoration of Huxley's birthday by an annual lecture delivered at the College with which most of his teaching life was associated, is a new institution, which the Imperial College of Science owes to its Rector, Sir Thomas Holland, who himself was an old pupil of Huxley's. The first lecture in the series was delivered by Prof. E. B. Poulton in 1925 and was of a charming and intimate biographical character. The second lecture, by Dr. P. Chalmers Mitchell, should have been delivered last year, but had to be postponed owing to the general strike. It was delivered on May 4 of this year. Dr. Mitchell took as his title, "Logic and Law in Biology," and, as was to be expected, he delivered an admirably lucid and incisive address. Dr. Mitchell's thesis was that it is a weakness of the human mind to invent imaginary entities to account for the flux of things, and that of these entities the idea of 'law' is the most universal. He pointed out that Huxley had said that every law is a construct of the human intellect, and no more exists outside us than does colour. Dr. Mitchell then went to scourge the concepts of 'vitalism,' 'orthogenesis,' and 'emergent evolution.' If we get rid of all these conceptions, what remains? According to Dr. Mitchell, an increase of 'plain materialistic explanation.' But many will ask: Is not 'materialistic explanation' itself an imaginary concept? There was, in fact, an aura of nineteenth-century materialism and scarcely veiled 'episcopophagy' about Dr. Mitchell's address which was admirably in keeping with one phase of Huxley's character. But the same Huxley who on one occasion said that it was as absurd to talk of the 'vitalism' of an animal as of the 'horologity' of a clock, on another occasion declared that he was not a materialist because he could not conceive of matter apart from mind to picture it in.

DR. CHALMERS MITCHELL referred to biogenesis—the chief stumbling-block in the way of the thoroughgoing materialist. He pointed out that Huxley fully admitted that all life comes only from pre-existing life, but that he claimed the right to 'imagine' a condition in the past when life had arisen from dead matter. If science is the determination and measurement of the processes going on now and their imaginary prolongation into the past and the future, and if this procedure leads to the inference that a discontinuity occurred, then the scientific attitude is to recognise frankly that this is so. To say that it could not have been so, is to introduce an *a priori* conception such as Dr. Mitchell justly deprecates. Indeed, many biologists will maintain that Lord Kelvin's famous assertion that there are in the history of the universe at least two discontinuities which the theory of development cannot get over, namely, the primary concentration of energy and the beginning of life, remains as justified to-day as when he made it. Dr. Mitchell referred to numerous investigations which he claimed are reducing the gap between the living and the non-living. To the opposite school of thought the trend of the recent investigation is not in this direction. A few years ago it was thought that Amœba could be successfully imitated by a drop of rancid oil, and that all its motions were due to surface tension; now, a recent investigator tells us that if Amœba were the size of a dog, no one would refuse to call its actions intelligent.

BIOLOGISTS will be surprised to learn that Prof. Julian S. Huxley is resigning the chair of zoology in King's College, London, to which he was appointed less than two years ago. We understand that Prof. Huxley will still continue to be attached to King's College in an honorary capacity, but he intends to devote himself entirely to writing and research. Thus a new situation is created with regard to the purveyors of knowledge and their relation to academic institutions, a situation which all who are concerned with the spread of knowledge will do well to examine thoroughly. With the spread of popular education and the use of applied science there has come into existence not only a large body of the general public which desires further knowledge, but also, in the shape of cheap printing, broadcasting, instructional films, and the systematisation of popular lectures, the means for gratifying this desire without recourse to formal lectures at a college or university. The use of broadcasting and the cinematograph is now being officially encouraged for instruction in schools. The successful 'libraries' issued by various publishers, such as the Home University Library, Benn's new Sixpenny Library, and other similar ventures, show what can be done with educational series; works like Wells's "Outline of History," what can be done with the single book; the University Extension Lectures and the classes arranged by the Workers' Educational Association—which some members of the Royal Commission on Oxford and Cambridge thought the most important innovation in university practice which had ever occurred—the Chautauqua, the organised lecture-tours of the United States, what can be done with lecturing partly or wholly detached from academic institutions.

THESE gateways to knowledge are of great importance to the learner; but their importance to the teacher seem not yet to have been fully realised. They imply that an increasing number of those who are interested in teaching or in the pursuit of knowledge for its own sake will be able to make a livelihood without lecturing to students in a college or university. On the other hand, it will obviously be of advantage to such workers to be connected in some way with academic institutions, with their facilities for research and study and their atmosphere of learning; it will equally be of advantage for the academic institutions to be associated with any new means of spreading knowledge, and with any one, whatever his method of obtaining a livelihood, who desires to devote his energy to pure research. It will be interesting to see how educational organisation will adapt itself to the new situation which is thus arising, and in particular to follow the success of this new and courageous venture of Prof. Huxley.

IN the past twenty-five years, the Appointments Board of the University of Cambridge has effected quietly a noteworthy revolution in the attitude of tutors and undergraduates towards the business world and of the business world towards the universities. Where formerly men looked to an academic life, to the Civil Service, or to one of the professions as a natural sequel to a successful university career, now in growing numbers they are looking to the world outside, and the outside world is more and more seeking for men of proved ability with a university training. The immediate result is at present most apparent in the Far East, where, for example, Sir John Jordan has described the Cambridge graduates as having "changed the face of business in China," and where the great oil groups are relying with confidence to their staffs, mainly university men, to enable them to maintain their lead throughout the world. Firms and industrial organisations in Great Britain are also more and more inclined to turn to the universities for their administrative appointments, and along with this is a growing demand in industry for trained scientific workers for chemical, physical, geological, engineering, forestry, or agricultural work. The Appointments Board at Cambridge has, through its secretary, Mr. H. A. Roberts, gained the confidence of the business world and of Government departments, and serves now as the natural channel for meeting their demands. In meeting these demands satisfactorily it has also stimulated a wider demand. It will be of interest to watch in the coming years the reaction of this larger demand on the conditions of the alternative careers which are losing ground at present in the order of choice of the young graduate.

A PRELIMINARY programme has now been issued of the Leeds meeting of the British Association, to be held on Aug. 31-Sept. 7, under the presidency of Sir Arthur Keith. The president's address will be delivered in the Majestic Cinema, City Square, on Wednesday evening, Aug. 31, on the subject, "Darwin's Theory of Man's Descent as it stands To-day." Evening discourses will be given to members of the Association in the Albert Hall, Leeds, on Sept. 2 by Prof. R. A. Millikan on "Cosmic Rays," and on Sept. 5 by Dr. F. A. E. Crew on "The Germ-plasm and its Architecture." Public lectures are being arranged for Leeds and the neighbouring towns. Several excursions to local places of interest and to works and factories in or near Leeds are being organised, a civic reception will be held in the Art Gallery on Sept. 1, and the University will hold a reception on Sept. 6. The reception room during the meeting will be at the Town Hall; the local honorary secretaries for the meeting are Mr. James Graham and Prof. A. Gilligan, Education Department, Calverley Street, Leeds.

IN the issues of the *Morning Post* for May 4 and succeeding days, Dr. T. W. Gann publishes a further report on his investigations of Maya ruins in Yucatan in the present season. Writing from Belize, he says that his last expedition has proved somewhat eventful, his larger motor boat having been wrecked and the smaller left behind badly damaged, while the greater part of his equipment has been lost. At Ambergris Cay, off the north coast of British Honduras, he found evidence that this island had once been inhabited by a branch of the Maya who had developed along lines of their own. They worshipped a god, a short, round-faced, masked individual like nothing known on the mainland. Dr. Gann's objective was Tuluum, where he proposed to visit the jealously guarded country of the Santa Cruz Indians, the only pure-blooded descendants of the ancient Maya. Before reaching Tuluum, however, he landed at a place called Majanal, just south of Espiritu Santo Bay, on a report from his pilot that there were ruins in the neighbourhood. A search revealed a city literally buried in sand, which lay in terraces. On the highest of these, huge square stones were still exposed. The preservative qualities of sand should make this a profitable site for future excavation.

ON reaching Tuluum he found the ruins cleared of vegetation, and learnt later from the chief of the Santa Cruz Indians, by whom he was most hospitably received, that although they had a chapel in their nearby native *pueblo*, the temple was held in veneration and used by them. Dr. Gann took part in an elaborate religious ceremony in the old Maya temple before a cross draped with a native woman's skirt, and before which *jabin* branches were placed, this being the herb held peculiarly sacred to their gods by the ancient Maya. The celebrant at the service was a woman, the widow of the priest who had recently died leaving a son too young to learn the prayers. She conducted the service in Spanish, although she knew no word of the language, but the responses were given in Maya. The service opened with a fumigation of every one and the temple with aromatic resins to drive away the devils, and concluded with the drinking of a bowl of a mixture of ground corn and honey. Dr. Gann was able to collect much interesting information about the beliefs and customs of these survivors of the ancient Maya race, and obtained a unique photograph of the idol which they dread as an embodiment of evil.

AN interesting series of copies of frescoes from Theban tombs has been placed on exhibit in the British Museum on permanent loan. They have been executed by Mrs. N. de Garis Davies and belong to Dr. Alan Gardiner, but will ultimately become the property of the Museum. With the exception of copies made for the Metropolitan Museum of New York, this is the only representative collection of reproductions of this class of Egyptian art. The examples which have been chosen for exhibition go back in date to so early as 2150 B.C. They have been selected especially with the view of covering as wide a field as possible in illustration of the social life and history of the early Egyptians. The earliest example shows women baking cakes. A representation of women at a feast of 1420 B.C. is interesting as illustrating the custom of placing solid unguents on the head at a feast, which melted and ran down over the hair, face and even garments. The motives of conventionalised spirals and lotus flowers used as the decoration of the ceilings of tombs are illustrated in frescoes of about 1300 B.C. A cat seated beneath the chair of its mistress and another eating fish, from the tombs of the astronomer Nakht and the Harbour Master are successful examples of Egyptian realism, more happy, indeed, than the leashed hound from the tomb of Rekhmire. Paintings showing relations with Crete are well represented. A drawing from the tomb of Tut-ankh-amen's governor of Syria will no doubt prove attractive on the ground of its associations. Among other features represented are negroes carrying tribute, and Ethiopians with cattle having fetishes on their horns, golden rings and a giraffe. There are also shown cattle, mourning women in a boat, and Kenre and his wife Mutemnia drinking from a pool in the fields of the dead. As an exhibit the collection is one of the most attractive and, possibly, instructive now in the gallery.

IT is announced that a decision taken at the concluding meeting of the International Congress of Orientalists at Athens in 1912 that the next meeting of the Congress should be held at Oxford is to be given effect. With the consent of the Vice-Chancellor of the University, the seventeenth International Congress will be held there during the week beginning Aug. 27, 1928. The approval of the Royal Asiatic Society has been obtained, and the leading oriental societies of France, Italy, Germany, Holland, and America have signified their intention to take part. The arrangements for the meeting are in the hands of the members of the Oriental Faculty of the University. It is to be hoped that the Congress will be strongly supported, for circumstances combine to give it a special importance. During the interval which has elapsed since the last meeting the international bonds of common study have been strained and broken, while for Great Britain as an Empire with vital interests in the Middle and Farther East, the course of events since the War has given a peculiar significance to the subject-matter with which the Congress deals as one, and not the least important of the avenues by which we may arrive at an understanding of the mind of the various Eastern races. In the circumstances, no more appropriate meeting-place for the Congress than Oxford could be found. We trust, therefore, that the Oriental Faculty of the University may receive wide public support.

The new laboratories of the Metropolitan Asylums Board at the Park Hospital, Hither Green, London, S.E., were opened on May 9 by Mr. Neville Chamberlain, Minister of Health. The buildings, which have cost about £13,500, have been equipped for research on the primary causation of infectious diseases and particularly acute fevers. Mr. Chamberlain, in his address, said that about 5 per cent. of the children born in London die from infectious disease before reaching twenty years of age. Apart from the suffering, this constitutes a great waste of human material, and Mr. Chamberlain expressed surprise that local authorities throughout Great Britain, which have to meet expenditure for isolation hospitals and treatment of infectious disease, have not done more in the past to discover the causes and means of prevention of such diseases. The results already achieved by the investigation of scarlet fever and diphtheria have been most encouraging and have shown that money spent on research in this field is a good investment.

On Tuesday, April 26, a numerous party of members of the Illuminating Engineering Society and friends paid a visit to the National Physical Laboratory, Teddington, and were afforded an opportunity of inspecting the Photometric Section under the supervision of Mr. J. W. T. Walsh. Some of the most interesting features of the work were summarised by Mr. H. Buckley, who pointed out how it has become interlinked with that of other bodies, such as the Illuminating Engineering Society, and directed attention to the variety of researches being conducted for Government departments. In addition to the important work dealing with the unit of light, such problems as the design of picture galleries, the requirements for ships' navigating lights, the effects of glare, the relation between illumination and the carrying out of fine work, and reflection of artificial light from road surfaces have been studied. The visitors were afforded an opportunity of seeing the apparatus for such tests in operation, and much interest was taken in the equipment, notably the new 10-ft. diameter integrating sphere now installed. It was recalled in the discussion that the problem of devising a primary standard of light was raised in a comprehensive paper on photometry read by Prof. J. A. Fleming nearly twenty-five years ago. Research on this difficult problem is still proceeding at the National Physical Laboratory and elsewhere.

The annual cider-tasting day took place at the University of Bristol Research Station, Long Ashton, on Thursday, May 5. The gathering was a record one, about 1000 visitors—mainly fruit growers, cider makers, and agriculturists—being present on the occasion. In addition to the usual display of single variety ciders made during the past season from the 1926 crop, there were exhibited ciders made from apples submitted by farmers of the surrounding counties in connexion with the Institute's scheme of cider-apple competitions. These competitions are designed to demonstrate to farmers the cider-making values of the various varieties grown in the different localities and to stimulate interest in the growing of high-grade cider fruit to meet the greatly increased requirements of the cider industry. The competitions are extremely popular with the farmer, and have proved of definite value to the Station for research purposes. During the day, parties of visitors were conducted around the laboratories and field plots by members of the Station staff, who demonstrated the practical results of the Institute's research work on problems of fruit culture. Special parties of fruit growers were organised for demonstrations of the results of research work on strawberries and for practical demonstrations in the making of spray fluids. Demonstrations of the use of various new models of motor-driven cultivators suitable for use in fruit plantations and of the latest types of spraying machines for applying spray fluids and 'dusts' were given by commercial firms throughout the day.

Dr. L. Prandtl, professor of applied mechanics in the University of Göttingen, has been awarded the Gold Medal of the Royal Aeronautical Society, in recognition of his work on aerodynamics. The medal will be presented on May 16, when Dr. Prandtl will deliver the fifteenth Wilbur Wright memorial lecture.

It will be remembered that a fund was subscribed by friends and old students of Dr. J. A. Fleming for a portrait to be presented to University College, London, in commemoration of his forty-two years' tenure of the chair of electrical engineering in the College. The portrait, which was painted by Sir William Orpen, is considered to be an excellent likeness, and is being exhibited in Room XI. at the Royal Academy.

Mr. T. H. Savory, Biological Laboratory, Malvern College, Worcs., informs us that he is at present engaged in the compilation, for the Welsh National Museum, of a list of the spiders of Wales, to accompany a type collection which has recently been presented to the Museum. Records are not numerous, and it is desirable to be complete, if possible. Mr. Savory would therefore be glad to know of any work on Welsh spiders which has not been published or is not generally accessible.

Information has been received of further discoveries bearing upon the early peoples of East Africa by Mr. L. S. Leakey of the East Africa Stone Age Expedition. Portions of thirty-six skeletons have now been unearthed, of which twenty-six were found in the Elmenteita district. According to a dispatch in the *Times* of May 4, Mr. Leakey considers the Elmenteita type to be even more primitive than that discovered at Nakuru in December last. In particular the nose is narrower, some individuals having a nasal index of 44. As a race they were tall, and differ markedly from the existing peoples of Kenya.

THE council of the Institution of Civil Engineers has made the following awards in respect of papers read and discussed at the ordinary meetings during the session 1926–27: Telford Gold Medals to Mr. I. J. Jones (London) and Mr. T. B. Hunter (London); a Watt Gold Medal to Mr. Gerald Curry (London); and a George Stephenson Gold Medal to Mr. A. L. Bell (Malta); Telford Premiums to Mr. A. W. Stonebridge (Bombay), Mr. P. R. Roberts (Barrow-in-Furness), Mr. A. C. Anderson (London), and Mr. George Ellson (London); a Manby Premium to Prof. Douglas Hay (Sheffield); and a Trevithick Premium to Mr. Powys Davies (India).

THE Paris correspondent of the *Times* announces that Baron Edmond de Rothschild, who has already done great service to scientific research in France by creating the Rothschild Foundation, has made another gift of 30,000,000 francs to the foundation for the purpose of endowing an institute for physical and chemical research as applied to biology. The work of the institute is to be conducted by a committee consisting of Profs. Jean Perrin, Job, and André of Paris, and M. Pierre Girard.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A junior assistant hydrographic surveyor under the Port of London Authority—The Staff Manager, Port of London Authority, Trinity Square, E.C.3 (May 18). A lecturer in pharmacology and therapeutics at St. Bartholomew's Medical College—The Dean of the College, St. Bartholomew's Hospital, E.C.1 (May 20). A junior scientific assistant for Admiralty Research—The Secretary of the Admiralty (C.E. Branch), Whitehall, S.W.1 (May 21). A full-time lecturer in chemistry at the Polytechnic, Regent Street—The Director of Education, The Polytechnic, 309 Regent Street, W.1 (May 23) A full-time teacher of geography at the City of London College—The Secretary, City of London College, White Street, E.C.2 (May 27). An assistant lecturer in physiology in the University of Birmingham—The Secretary of the University (June 1). A professor of zoology at King's College, London—The Academic Registrar, University of London, South Kensington, S.W.7 (June 2). A part-time research organiser under the Research Fund Committee of the Institute of Brewing—The Secretary, The Institute of Brewing, Brewers' Hall, Addle Street, E.C.2 (June 3). A full-time lecturer in electrical engineering at the Borough Polytechnic Institute—The Principal, Borough Polytechnic Institute, Borough Road, S.E.1. An assistant master for electrical engineering at the Rugby Technical School—P. I. Kitchen, 61 Clifton Road, Rugby. A graduate to teach botany at the Erith Technical College—The Principal, Technical College, Erith Road, Belvedere. A full-time mistress for mathematics and science at the Girls' Trade School of the Borough Polytechnic Institute—The Principal, Borough Polytechnic Institute, Borough Road, S.E.1. A part-time mistress for hygiene, physiology, health, and science subjects at the Borough Polytechnic Institute—The Principal, Borough Polytechnic Institute, Borough Road, S.E.1.

ERRATA.—In NATURE of April 30, p. 629, col. 1, line 29, for "Haustein" read "Hanstein," and line 47, for "Sonèges" read "Souèges."

Our Astronomical Column.

GLOBULAR CLUSTERS AND SPIRAL NEBULÆ.—An article by Mr. A. R. Hinks in the *Nineteenth Century* for May gives a vivid account of the great enlargement of our conception of the size of the visible cosmos that has resulted from the work of Hale, Shapley, and Hubble at the great American observatories. The various stages in the deduction of the absolute magnitudes of the Cepheids are lucidly described; but one point in the proof, the practically perfect transparency of the celestial spaces, seems to need fuller treatment than is given in the article. The shortest proof appears to be the simultaneity of phase in light of different colours, whereas their speeds would be different in an absorbing medium.

Mr. Hinks was the first to detect the asymmetrical arrangement of the globular clusters: they lie in one hemisphere of the sky, with its pole in the galaxy. Further, their number is limited to about ninety, and no increase in optical power seems to add to it, so that they belong to a rather special class of objects, the curious grouping of which is still unexplained and merits further study.

Brief allusion is made in the article to Prof. Hubble's recent paper in the *Astrophysical Journal*, in which he assigns a distance of 140,000,000 light years to the smallest visible spiral nebulæ. Representing the distance of α Centauri as one inch, these objects would be 550 miles away. Some verses by G. M. Minchin appeared in NATURE, April 14, 1898, p. 564. One verse ran:

> "For, the rays that reach me here
> May have left your photosphere
> Ere the fight of Waterloo—
> Ere the pterodactyl flew!"

The last line was probably intended as a bold exaggeration, but Hubble's result would make it literally true.

ASTROPHYSICS IN RUSSIA.—The State Astrophysical Institute of Russia is publishing *Trudy* (Memoirs), the first volume of which appeared in 1922, the second in 1923, and two parts of the current third volume in 1925 and 1926, respectively. The contents of the published volumes are very varied, both theoretical papers and those elucidating various practical points of astrophysics being well represented. To the former category belong papers by V. A. Kostizyn on masses of stars and on equilibrium of radiation in stars; those by V. G. Fesenkov on the evolution of the solar system, on cosmic refraction, on the structure of the atmosphere from photometric observations, and others. Some of the practical papers deal with the technique of stellar photography in particular cases; B. V. Numerov describes a new method of determination of orbits and of calculation of ephemerids; E. K. Epik writes on photometric properties of air and of clouds (with an explanation of variations in the brightness of Venus). The latest volume contains a catalogue of equatorial components of velocities of 1470 stars.

Research Items.

Pre-Columbian Huastec Mounds in the Tampico Region, Mexico.—Municipal and other work carried out at various times in the Tampico district of Mexico, which has necessitated the demolition of a number of the many mounds in the area belonging to the Huastec civilisation, has at the same time made it possible to form an accurate idea of their composition and structure. A number of observations of a series of mounds on one of the haciendas and on a series on the Colonia Flores on the north-western environs of Tampico are recorded in a paper contributed to the *Journal of the Royal Anthropological Institute*, vol. 56, pt. 2, by Mr. John M. Muir, who has been assisted in the mapping of the mounds by Mr. Cecil Drake. The mounds were used as the foundations for buildings, and were clearly raised or reconstructed from time to time, a cement floor being laid on each occasion. Sometimes as many as five floors were found in one mound. Steps were built for easy ascent to the floor of occupation, which in all likelihood was covered by a wooden structure. Any material conveniently available was used—shells, stone slabs, and even asphalt. Where no other material was available, soil was used. Oyster shells from pleistocene deposits were abundant on the Colonia Flores site, and were also used to form the cement floors. In one of the mounds a painted design was found which had been executed in a reddish colour and then apparently coated over in black. The drawing is 270 cm. long and 135 cm. wide and is approximately rectangular, resembling a ground plan in appearance. On the cement floor underlying this was found another painted design similar in character but more elaborate and complete. No purpose can at present be suggested for these designs.

Eye-strain in the Hosiery Industry.—No. 40 of the Reports of the Industrial Fatigue Research Board, by H. C. Weston and S. Adams (London: H.M. Stationery Office, 1927. 1*s.* net), deals with the effect of eye-strain on the output of linkers in the hosiery industry. The output of three operatives was recorded for a period of four weeks in order to determine the normal rate of working under existing conditions. The operatives were then examined and fitted with glasses suitable for the nature of the work, which involved a high degree of accommodation and convergence of the eyes. The output was then measured as before. The data show that the use of the glasses had important results. In the first place, the general rate of output was increased; and secondly, the usual fall of the output at the end of the day was considerably reduced. The subjects themselves experienced great relief as a result of wearing the glasses; their eyes did not feel so tired either during the working day or when they returned home at night. The writers suggest that it might be an advantage in other operations which make heavy demands on the eyes to wear suitable glasses. They point out, though, that it will always be necessary to examine and prescribe for each subject individually.

Fishing Industries of the Thames Estuary.—Reference was made last year (NATURE, June 19, 1926, p. 870) to a printed portion of Part 2 of the late Dr. Murie's "Report on the Sea Fisheries and Fishing Industries of the Thames Estuary," Part 1 of which was published in 1903. We are now advised by Mr. W. Pollitt, Borough Librarian and Curator of the Public Libraries and Museum, Southend-on-Sea, that a large portion of the remainder of Part 2 has been recovered. This consists chiefly of working proofs and 'galley' proofs, but what remained of Section 6, dealing with "Special Estuarine Fishes," which was in manuscript and rescued from a damp outhouse, has been so far as possible transcribed. Part 2 as it now exists is a folio volume of 256 pages, and in addition there is a number of drawings intended to illustrate it. The work is exceedingly valuable, embracing notes by an experienced authority on a large range of problems relating to the fisheries industries, much of which is new, and the whole brought together in a useful form. The part in question includes sections on whales, crustacea, shellfish, fishing grounds, nets, etc., plaice, spratting, whitebaiting, smelting, eel-spearing and trawling, spruling, shrimp trawling and shrimping, crab and lobster fishing, prawning, oyster industry, clam digging, scallop dredging, whelk trotting and potting, starfish, white weed gathering, and dredging. There are also sections on the Leigh fishermen, the fishing craft, apparatus for capture, cooking, transport, etc., fish products and economics of the fisheries. It would be a great pity if this work were lost, and it is apparently a question of funds as to whether it should be published. It is at present available for reference at the Library of the County Borough of Southend-on-Sea, and students interested in the subjects are invited to consult it.

Chromosomes of Dioecious Plants.—From a study of root-tips in *Vallisneria spiralis* and *V. gigantea*, Mr. C. A. Jorgensen (*Jour. Genetics*, vol. 18, No. 1) finds 20 chromosomes in the former (3 long pairs, 2 intermediate pairs, and 5 short pairs), while the latter species is tetraploid, having twice as many of each type of chromosome. Moreover, in these dioecious species the chromosome number and morphology appear to be the same in male as in female plants. These studies are confirmed by examination of the nuclear division in the pollen grains, in which the corresponding haploid numbers are found. Loss of chromosomes and probable non-disjunction is also found in the pollen meiosis, which accounts for the numbers observed by Winge, who mistook these conditions as indicating the presence of an XO set of sex chromosomes. Winge confirms this in the same issue of the *Journal of Genetics*, a lagging chromosome which he mistook for the X-chromosome being occasionally left behind and two chromosomes sometimes becoming attached to each other. Similarly in *Najas marina*, another dioecious plant, he finds no sex chromosomes, but in somatic cells sometimes 12, sometimes 14 chromosomes, owing to the smallest two pairs being more or less united. In the reduction division, six gemini are accordingly found, but Guignard occasionally found seven.

The Serpentine Belt of Burma.—The *Journal of the Burma Research Society*, 16, p. 176, 1927, contains an interesting account of the serpentines of Burma by H. L. Chhibber. The intrusions described occur in the Henzada and Bassein districts, and consist of wholly or partly altered saxonites, lherzolites, and dunites. Hornblende-eclogite is also described. As usual, chromite occurs in segregated patches, but communications are still too bad to encourage the commercial exploitation of this mineral. The intrusions form part of a long interrupted belt of similar rocks that extend from the Andamans through the Arakan Yomas and the Chin Hills to the northern frontier of Burma. In Burma the belt is roughly parallel to the Irrawaddy-Chindwin valley and to the central volcanic line of the country. The author considers the age of the intrusions to range from late Cretaceous to early Eocene. Nummulitic andstones referred to the Laki stage contain derived ragments of serpentine, and are themselves invaded by later ultrabasic rocks.

The Glacial Origin of Drumlins.—In the *Geological Magazine* for April, Prof. J. K. Charlesworth marshals a convincing array of evidence against Prof. J. W. Gregory's recent advocacy of the view that drumlins have been carved out of boulder-clay by the post-glacial action of wind and rain. Drumlins are commonly elongated parallel to the *last* direction of ice-flow, though they may lie oblique to the striæ directions scored in a pavement rock during earlier stages. One end is usually narrow and tapering, the other broader and steeper, and the blunt end faces the direction of ice advance. This feature suggests moulding by a moving ice-sheet. Drumlins are sometimes found beneath the moraines and eskers accumulated during the last recessional phase; they may be scarped by late-glacial lakes and by the 25-ft., 50-ft., and 100-ft. seas demonstrated by the raised beaches of Scotland; and in the lake deposits occasionally found in the hollows between drumlins, remains of the Irish elk have been discovered. There is thus incontrovertible proof that the period of drumlin formation preceded the close of the Quaternary ice age. Moreover, on the post-glacial theory, drumlins should not be restricted in distribution to boulder-clay regions. Prof. Charlesworth points out, however, that although the post-glacial hypothesis is manifestly inadequate, the glacial-moulding hypothesis has not yet been convincingly developed from the physical point of view. The physics of ice flow is still too little understood for a final solution of the problem.

Deflexion of Atomic Rays.—Magnetic deflexion of atomic rays is a relatively new line of research, and Prof. O. Stern's critical discussion of the method in No. 8 of the last volume of the *Zeitschrift für Physik* comes very opportunely. Since it is necessary to measure a deflexion of the pencil of rays through a distance not very much greater than the width of the limiting slits, the intensity distribution in the final trace is evidently of importance, and Prof. Stern has shown that in one instance neglect of this has introduced an unrecognised error of not less than 20 per cent. The greatest uncertainty at present, however, is in the measurement of the intense inhomogeneous magnetic fields which have to be employed, where the accuracy has been limited by knowledge of the susceptibility of bismuth. If, as appears probable, the method now in use could be bettered, Prof. Stern believes that experiments with molecular rays would give at least as precise a value for e/m as those based on observation of the Zeeman effect. The paper is accompanied by an account of work done in Prof. Stern's laboratory on the magnetic moments of the atoms of thallium, potassium, and sodium, by Dr. Leu, and the moment of hydrogen, by Dr. Wrede; both authors have made refinements in the technique. To within a few per cent., potassium, sodium, and hydrogen all have a moment of one Bohr magneton, and thallium one-third of a magneton.

Density of Boron Trichloride.—The accurate determination of densities of liquids by means of glass floats has recently been applied by Robinson and Smith to the problem of the constancy of the atomic weight of silicon from different sources. In the February issue of the *Journal of the Chemical Society*, Briscoe, Robinson, and Smith have published the results of a similar investigation on the densities of different samples of boron trichloride. The approximate density of the trichloride (*D.* 1·350/11°) was determined by means of a glass hydrometer, and suitable floats were constructed and calibrated in *n*-propyl bromide (*D.* 1·364/18°). The densities of boron trichloride, prepared from boron obtained from California, Tuscany, and Asia Minor, were measured, and the relative atomic weights of the samples calculated. The results confirm the discrepancies between the atomic weights of boron from the three sources, which were first noticed in the ratios $BCl_3 : 3Ag$, and in the densities of the fused boron trioxide.

Cellulose Paints.—We have received from the Institution of Automobile Engineers a copy of a paper by W. F. Starkey on nitro-cellulose enamels. In view of the increasing importance of this type of varnishing medium, especially in the motor-car industry, the information which the paper contains is of great interest. A typical nitro-cellulose paint contains nitro-cellulose of suitable solubility and viscosity, solid or liquid plasticisers to impart flow to the material, and a gum resin which will give gloss to the finished product without detracting from the surface hardness, dissolved in a solvent with as high a degree of volatility as is commensurate with the avoidance of chilling and with ease of application. The enamel is applied by the use of a spray pistol, after the surface to be treated has been thoroughly cleaned. It dries in half an hour, is harder than ordinary enamel, resists acids, alkalies, petrol, and heat, and although it has less gloss than ordinary enamel, this improves with cleaning and rubbing. The plasticisers and softeners used in the preparation of cellulose lacquers and paints are discussed by T. H. Durrans in the *Chemical Trade Journal* for Mar. 11. Plasticisers are required to impart a degree of elasticity to the film, as a rapidly drying paint is very brittle. The properties of sixteen organic substances of high boiling-point which are used as softeners and plasticisers are discussed in this article. The best cellulose enamels contain medium boiling-point solvents and high boiling-point plasticisers.

Wallis's Axiom of Parallels.—It is well known that Euclid's axiom of parallels is independent of the other assumptions made by him, and that several axioms have been suggested in place of that given by Euclid. Among these is Wallis's axiom that "to every figure there exists a similar figure of arbitrary magnitude." Prof. M. J. M. Hill, in his presidential address to the Mathematical Association (*Math. Gazette*, March 1927), has simplified Wallis's axiom to the following: Given any triangle, then a triangle with angles congruent to the corresponding angles of the given triangle can be constructed on any given base, and on a given side of the base. Assuming then some axioms on the congruence of angles, but without assuming anything on the congruence of intervals or of triangles, and without making any appeal to continuity, he shows that his axiom leads to the Euclidean parallel axiom both in the form given by Euclid and in Playfair's form, and that the further axiom that all right angles are congruent can also be shown from the same basis. This part of geometric theory thus involves the congruence of angles only and can be treated independently of the rest of geometry. Of the other substitutes for Euclid's axiom, besides Playfair's form, the best known is that which asserts that the sum of the angles of a triangle equals two right angles. But to deduce the Euclidean axiom from this, the full theory of the congruence of triangles is needed, and furthermore, as Dehn has proved, the axiom of Archimedes has to be assumed. The Wallis-Hill axiom thus supplies a much simpler basis for this part of geometry.

The Himalayan Silver Fir and Aeroplane Construction.

AN important communication (*Indian Forest Research Institute Bulletin*, No. 69 Economy Series, 1926) has been recently issued from the Research Institute at Dehra Dun, India, dealing with "The Mechanical and Physical Properties of Himalayan Spruce and Silver Fir." The work of the various branches of the Research Institute is laid down on a triennial basis, lines of investigation to be undertaken being entitled "Projects." The present bulletin refers to timber-testing work under Projects Nos. I. and II. on *Picea Morinda* and *Abies Pindrow*.

These two species have been but sparsely utilised by the markets up to date owing to costs of extraction and a lack of knowledge as to the properties of the timbers. They exist in large quantities in northern India. Spruce is found in the Himalayan tracts from Afghanistan to Kumaon, from 7000 ft. to 11,000 ft. elevation, and commonly mixed with fir, deodar, and *Pinus excelsa*. The silver fir extends from Afghanistan to Nepal, from 7500 ft. to 11,000 ft., sometimes as pure crops but commonly mixed with spruce, deodar, and *Pinus excelsa*, and at times associated with broad-leaved species. It is estimated that existing mixed spruce and silver fir forest could supply a sustained annual yield of more than two million cubic feet, the best localities being enumerated. Both species grow to a large size. Himalyan spruce are reported up to 215 ft. in height and as much as 23 ft. in girth, whilst the Himalayan silver fir has reached a size of 202 ft. in height and 26 ft. in girth.

The investigations carried out in the timber-testing branch of the Institute were undertaken in order to ascertain the strengths of the two timbers for constructional, aeroplane, and other purposes. Incidentally, the question as to whether the spruce red wood was inferior to spruce white wood was decided. The impression that such is the case is commonly held. The investigations showed, however, that the red wood, which is simply the darker, denser material near the centre of the lower portion of the tree-trunk, is in no way inferior to spruce white wood when taken from healthy living trees. The tests have demonstrated that the timber of silver fir has proved to be stronger than the spruce, which is also the case, in some parts, with the European species of these genera. Apart from its scientific aspects, the bulletin has both a commercial and Empire value owing to the deductions derivable from the tests.

The two principal causes which have led to complaints, both from the match manufacturer and others, and to the restricted use of these two conifers in India, are the prevalence of knots and the lack of durability of these timbers. The comparison has usually been made with some of India's most valuable timbers, such as deodar, teak, *Xylia dolabriformis*, and so forth. A similar comparison in Europe would be to contrast silver fir and spruce with oak. The tests have shown that the Himalayan spruce and silver fir are at least as durable as and stronger than the corresponding species of Europe and America. The investigations carried out were made on similar lines and are strictly comparable with the results obtained in the Forest Products Laboratories both in Canada and the United States. The Himalayan silver fir has been proved to be stronger than Sitka spruce (*Picea sitchensis*), the accepted conifer for use in aeroplane construction. It is held that the Himalayan species are not more knotty than the spruces and firs of other parts of the world, with the exception of the Sitka spruce. The tests have shown that the silver fir is less knotty than the spruce in the Himalaya, and a case appears to have been made out for a careful survey of the denser older forests of the former species with the view of the possibility of their being able to furnish aeroplane material.

It is a common British failing to suppose that the foreigner has a better article than can be obtained in the Empire, so this careful piece of research work deserves to be widely known. For the time is assuredly approaching when the silver fir and spruce belt of the western Himalaya will furnish its quota to assist the rapidly dwindling soft-wood supplies of the globe.

The Influence of Impurities on Copper.

THE work that Prof. D. Hanson and his co-workers have been carrying out on the effect of various impurities on copper of the highest degree of purity is extended in two papers read recently before the Institute of Metals. The first of these, in collaboration with Miss G. W. Ford, deals with the influence of bismuth, the solubility of which in solid copper is less than 0·002 per cent. Small amounts of this element adversely affect the rolling properties of copper, particularly during hot-rolling, and the limiting percentage for this process appears to be less than 0·01 per cent. In cold-rolling, the material fractured when more than about 0·05 per cent. of bismuth was present. Even with smaller amounts the effect is bad, especially where the degree of cold-work is great. The effects of this impurity on the electrical conductivity and tensile strength are small.

The second paper, carried out in collaboration with C. B. Marryat, deals with the influence of arsenic, alone and together with oxygen. Copper containing up to 1 per cent. of arsenic alone is very difficult to produce as completely sound castings, but the presence of a little oxygen greatly improves the casting properties. The copper-arsenic alloys are, however, exceedingly ductile and can be worked, both hot and cold, to almost any desired extent. Arsenic alone has but a small hardening effect on pure copper, the Brinell hardness of which, in the annealed state, is almost constant, nor is the ductility greatly affected. In the case of cold-worked metal the arsenic does definitely increase the hardness. The ratio of the fatigue range to the tensile strength of arsenical copper is relatively high, about 0·9; higher, that is, than in copper containing oxygen or iron. The effect of the element on the electrical conductivity is profound, being much greater than that of either of the two latter metals. It reduces the size of the crystals in the castings, but has no appreciable effect on the structure of worked and annealed copper. The solubility of arsenic in solid copper is about 7·25 per cent., a figure which alters little with temperature.

The simultaneous presence of arsenic and oxygen leads to the following effects. The presence of arsenic reduces the deleterious effects of oxygen on the cold-working properties of copper. As the ratio of arsenic to oxygen is raised the cast bars become more ductile, but, unless this ratio is high, the metal is in an over-rolled condition and for severe cold-work the arsenic must exceed ten times the content of oxygen, and a much higher ratio than this is still quite satisfactory. The necessary ratio of these two impurities depends on the amount of cold-work to be done; the greater the amount of cold-working, the greater is the amount of arsenic required. Hot rolling of the copper containing both elements can be done without difficulty.

The mechanical tests differ little from those given by arsenic without oxygen, and the same applies to the electrical resistivity. The oxygen, which occurs in pure copper as cuprous oxide, combines, when more than 1 per cent. of arsenic is present, to form a slaty-grey compound which is a reaction product of cuprous oxide and arsenic. The softening temperature of copper is raised by arsenic whether oxygen is present or not. Arsenic is without effect on the tendency of copper to become brittle through heating in hydrogen.

F. C. T.

University and Educational Intelligence.

Bristol.—Four scholarships are offered by the Society of Merchant Venturers to matriculated candidates of not less than 17 years of age. The scholarships provide free tuition; one is open to pupils in any secondary school; three are restricted to pupils of secondary schools situated in the counties of Gloucestershire, Somerset, and Wiltshire. A War Memorial scholarship is also offered, with a preference to a candidate needing pecuniary help who is the son of a former student who lost his life while serving with H.M. Forces during the War. Further particulars can be obtained from the Registrar of the Merchant Venturers' Technical College.

Cambridge.—Mr. H. E. Tunnicliffe, Gonville and Caius College, has been appointed University demonstrator in physiology.

Oxford.—The Halley Lecture for 1927 will be delivered on Friday, May 20, at 5 p.m., in the University Museum, by Lieut.-Colonel F. J. M. Stratton, of Gonville and Caius College, Cambridge, on the subject of "Modern Eclipse Problems."

Dr. William Thomas, lecturer in chemistry in the University of Aberdeen, has been appointed principal of the Denbighshire Technical Institute, Wrexham, North Wales.

Prof. H. H. Turner, Savilian professor of astronomy in the University of Oxford, will deliver a lecture at Birkbeck College, London, on May 25, on "The Total Eclipse of the Sun." The lecture is one of the special lectures arranged for teachers by the London County Council.

Courses of free public lectures have been arranged by the Armourers and Brasiers' Company as follow: "Special Steels and their application in Engineering," by Dr. W. H. Hatfield (at the Sir John Cass Technical Institute, on May 17 and 31 and June 14, at 6.30), and "Oxidation, Corrosion, and Passivity of Metals," by Mr. U. R. Evans (at the Royal School of Mines, on May 18 and 25 and June 1, at 5.30). No tickets will be necessary. The Armourers and Brasiers' Company has founded senior industrial bursaries of £170 per annum and junior industrial bursaries of £50 per annum, the former to assist young men who have obtained honours at the final examination at the University of London for the degree of B.Sc. (Eng.), (mining) or (metallurgy), to enable them to prosecute further studies, and the latter to enable youths who have shown promise in their preliminary studies in subjects relating to engineering or metallurgy to continue those studies.

Calendar of Discovery and Invention.

May 16, 1888.—Whereas in the phonograph Edison made his sound records by causing the engraving tool to rise and fall, Emile Berliner in his gramophone employed a tool moving from side to side in a spiral groove cut in a disc. Berliner's original gramophone was first publicly exhibited in the Franklin Institute, on May 16, 1888, and it is now in the National Museum, Washington, D.C.

May 17, 1823.—Jacob Perkins was one of the pioneers of the use of high-pressure steam in engines, and he was also the first to put into practice heating by steam, the British patent for which is dated May 17, 1823.

May 18, 1825.—In the minutes of the Royal Society of Arts for May 18, 1825, is a report on Sturgeon's apparatus for exhibiting the principles of electro-magnetism. It was then resolved to award Sturgeon the Silver Medal and thirty guineas on condition of his leaving a complete apparatus and description thereof with the Society for the use of the public and relinquishing all pretensions to a patent. Included in this apparatus was the first electro-magnet, a horse shoe of soft iron made from a round bar about ½ in. in diameter wound over with about eighteen turns of copper wire. Though this historic gift has been lost, the transactions of the Society contain an illustration of it, and by means of this Prof. Fleming had a replica made which he presented to the Science Museum, South Kensington.

May 19, 1766.—When Euler left Berlin for St. Petersburg, D'Alembert suggested to Frederick the Great that his place in the Academy of Sciences should be filled by Lagrange. To this Frederick agreed, and on May 19, 1766, D'Alembert wrote to the King, "Je me tiens trop heureux d'avoir pu réussir dans cette négociation, et procurer à Votre Majesté et à son Académie, un si excellent sujet. Cet événement répand dans mon âme une satisfaction dont je n'ai pas joui depuis longtemps, et je suis sûr que mon estomac s'en ressentira."

May 19, 1919.—The first to attempt the direct flight from America to Europe for the £10,000 prize offered by Lord Northcliffe were Hawker and Grieve, who on May 19, 1919, set out from St. Johns, Newfoundland, in a Sopwith biplane driven by a Rolls-Royce engine. They had flown about 1100 miles in 14½ hours when the cooling water arrangements of the engine failed. It being impossible to complete the journey, search was made for a ship and the aeroplane brought down in the water close to her, both pilots being rescued and brought to England.

May 20, 1859.—Through information regarding the work of James Young on the distillation of oil, efforts were made to bore for oil in the United States. The first, however, to sink such a well, and thus become the founder of the great petroleum industry of America, was Colonel Drake, who on May 20, 1859, with four companions, began drilling in the woods of Pennsylvania, and after three months' strenuous work obtained oil from the rock on Aug. 27, 1859, for the first time.

May 21, 1797.—"Wherever the steam-mill resounds with the hum of industry, whether grinding flour on his native Schuylkill or cutting logs in Oregon, there do you find a monument to the memory of Oliver Evans." This tribute recalls the inventor who worked out the modern system of flour milling and was one of the first to use high-pressure steam. Among his patents was that of May 21, 1797, for a steam-driven carriage. He afterwards made a crude steam-driven vehicle and also a steam dredger.

E. C. S.

Societies and Academies.

LONDON.

Royal Statistical Society, April 26.—**Miss E. M. Newbold**: The practical application of the statistics of repeated events with special reference to the personal factor in industrial accidents. The Industrial Fatigue Research Board has in progress an inquiry into individual liability to accident, and the possibility of sorting out persons who ought not to be placed in particularly dangerous occupations. Records of minor accidents among various groups of factory workers, dockyard apprentices, and Royal Air Force apprentices have been compared with the results obtained with selected psychological tests. The statistical side of this investigation, and the effect of chance variation on figures of this kind, were discussed. As regards these minor accidents, the average rate is considerably affected by a comparatively small proportion of people with repeated accidents, whose liability shows measurable stability when they are observed over successive periods and also in different circumstances. These same people also report sick for various minor ailments more frequently than their fellow-workers.

PARIS.

Academy of Sciences, April 4.—**Marcel Brillouin**: Oceans and continents. Oceanic tides and soil tides. Normalised formulæ for their theoretical calculation. —**C. Matignon** and **M. Piettre**: The preparation of beryllium chloride. Beryllia, heated to between 700° and 800° C. in a pyrex glass tube and submitted to a current of chlorine carrying the vapour of sulphur chloride, is readily converted into beryllium chloride, which volatilises. Sulphur chloride may be replaced by the vapour of carbon tetrachloride or by phosphorus trichloride, but in the latter case the product is contaminated with a little phosphorus trichloride.—**de Sparre**: Remarks on the note by M. Sugot, of Feb. 28, 1927, on the integration of the differential equations of the gyroscopic motion of a projectile.—**Jean Baptiste Senderens**: The catalytic decomposition of formic acid. Study of the rate of production of carbon monoxide by the action of sulphuric acid of various strengths and of other catalysts (anhydrous aluminium sulphate, potassium bisulphate, orthophosphoric acid) on formic acid.—**Charles Nicolle, H. Sparrow**, and **E. Conseil**: The preventive vaccination of man against exanthematous typhus by the use of small repeated virulent doses (brain of the guinea-pig).—**E. Cartan**: The geodesics of spaces of simple groups.—**A. Gheorghiu**: The growth of the denominator $D(\lambda)$ of Fredholm.—**D. V. Jonesco**: A problem relating to the theory of partial differential equations of the second order with real characteristics. —**Albert Portevin** and **André Sourdillon**: The influence of the tempering temperature on the deformations of steel cylinders.—**Barbillion**: The distribution of the Foucault currents in a metallic disc submitted to the action of an inductor pole of circular section, but eccentric with respect to the disc.—**Iser Solomon**: A direct reading and continuous radio-qualitometer. An instrument for measuring the quality of the X-rays when used therapeutically.—**C. Mihul**: The third order spectrum of oxygen.—**R. Descamps**: The rotatory dispersion in the ultra-violet of aqueous solutions of tartaric acid containing boric acid.—**Georges Fournier**: A relation between the atomic weights of isotopic radio-elements and the velocity of the α-rays which they emit. The velocity of the rays, v, is given by $v_0 - kA$, where v_0 is a term which varies from one group of isotopes to another, A is the atomic weight of the emitting radio-element, and k is a constant. Polonium forms an exception.—**René Audubert**: The determination of the energies of reaction by a knowledge of the active light.—**B. Bogitch**: The reduction of the oxide minerals.—**André Kling** and **Daniel Florentin**: The transformation of the phenols into hydrocarbons in the presence of catalysts and hydrogen under pressure. All aromatic and cyclohexane hydroxyl derivatives heated in the presence of hydrogen under pressure (70 kgm. to 80 kgm. per sq. cm.) with a dehydrating catalyst such as alumina, clay, thoria, silica, give good yields of the saturated hydrocarbons. Thus ordinary phenol with 5 per cent. of alumina heated with hydrogen under pressure to 480° C. gives benzene with some fatty hydrocarbons. Ordinary commercial cresol under the same conditions gives 35 per cent. of light hydrocarbons.—**Raymond Quelet**: Parabromobenzyl chloride and the Grignard reaction. The reaction between $BrC_6H_4CH_2Cl$ and magnesium gives parabromtoluene and *p.p.′*-dibromodiphenylethane.—**Maurice Nicloux**: The microestimation of carbon. Applications. The method is limited to those compounds which can be completely burnt by heating with sulphuric acid, potassium bichromate, and silver bichromate in solution. Test analyses of various organic substances are given, the quantities taken for analysis being 4 mgm.-16 mgm.—**Paul Corbin** and **Nicolas Oulianoff**: The *besimaudites* of Prarion (Haute-Savoie).—**Mlle. Rémy**: Experimental mutations and the mechanisms of spontaneous mutations.—**G. Nadson**: The perforating algæ of the Black Sea. The perforating algæ are very widely distributed in the Black Sea and play an important part in the destruction of the limestone coast, oyster beds, and generally all calcareous substances.—**G. Guittonneau** and **J. Keilling**: Rendering elementary sulphur soluble and the formation of hyposulphites in a soil rich in organic nitrogen.—**Emile André**: Relations between the development of the liver and that of the sexual glands in some cartilaginous fishes.—**A. Gurwitsch** and **G. Franck**: The mitogenetic rays and their identity with ultra-violet rays.—**Joseph Magrou** and **Mme. Madeleine Magrou**: Mitogenetic radiations and the genesis of tumours.—**Georges Lakhovsky**: The influence of the astral radiations on the oscillation of living cells.—**Henri Mémery**: The influence of the astral radiations on wines.—**Swigel** and **Théodore Posternak**: The preparation of polypeptides containing the phosphorus and ferric nuclei of ovovitelline.—**A. C. Marie** and **S. Mutermilch**: Attempts at antirabic vaccination of the rabbit in the meningeal cavity.

WASHINGTON, D.C.

National Academy of Science (*Proc.*, Vol. 13, No. 2, February).—**Norbert Wiener**: On the closure of certain assemblages of trigonometrical functions.—**G. Y. Rainich**: On a type of Lorentz transformations. —**Gordon T. Whyburn**: Cyclicly connected continuous curves.—**L. P. Eisenhart** and **M. S. Knebelman**: Displacements in a geometry of paths which carry paths into paths.—**Edwin H. Hall**: Photo-electric emission, thermionic emission, and Peltier effect (from the point of view of dual electric conduction). These effects can be accounted for on the assumption that the greater part of the current within a metal is carried by electrons travelling from atom to atom without sharing the heat energy and a much smaller portion by 'free' electrons.—**P. W. Bridgman**: The transverse thermo-electric effect in metal crystals. With single crystal bars of bismuth about 10 cm. long and 6 mm. in diameter, basal plane inclined at 20° to the length, a temperature difference of 0·4° C. between two sides of the bar was observed when currents of 1 amp. were passed along it. Similar but much smaller effects were obtained with zinc, tin, and cadmium. Kelvin's theoretical prediction of the effect is thus verified, but his reasoning seems inadequate. Regarding the current as an electron stream, the effect seems to be due to the reversible absorption or evolution of heat which occurs on the change of net direction of the electron stream with respect to a crystal axis inclined to the surface, after reflection from the surface.—**Worth H. Rodebush**: The effect of velocity distribution on the deflexion of atoms in an inhomogeneous magnetic field.—**Carl Barus**: Pinhole probe record of the closed organ pipe. —**A. H. Warner**: A comparison of the thermionic and photoelectric work functions for clean tungsten. The work functions in Richardson's thermionic equation and also in Einstein's photoelectric equation, which measure the work necessary to carry an electron from the interior of the metal to a position outside and beyond the influence of the image force, should, if conduction electrons are concerned in each process, be identical when measured at the same temperature. This has been verified within the limits of experimental error for clean tungsten illuminated by a quartz mercury arc and a monochromatic illuminator.—**Enos E. Witmer**: The quantisation of the rotational motion of the polyatomic molecule by the new wave mechanics. The polyatomic molecule is regarded as a rigid body with three principal moments of inertia.—**Stanley Smith**: A note on the spectrum of doubly ionised scandium.—**Robert E. Burk**: The thermal decomposition of ammonia upon the surface of a molybdenum wire. The effect of the initial pressure of ammonia upon the time of half life at 1228° Abs. suggests an apparent order of the reaction of zero. Hydrogen as an impurity was almost without effect; nitrogen caused marked retardation (catalyst poison), which persisted after pumping off to a vacuum. The results can be explained equally well by assuming that the reaction continues on parts of the surface not poisoned or that it can take place, at a reduced rate, on the poisoning film of nitrogen. Working at 1097°-1228° Abs., measurements of the temperature coefficient indicate a true heat of activation of 53,200 cal.—**A. V. Kidder**: Eskimos and plants. Fernald supposes that the highly specialised plants found in the Arctic Archipelago, the Torngat Mountains of Labrador, and similar localities in Northern America, are remnants of a general preglacial flora surviving in districts not covered by continental ice during the Pleistocene. It is suggested that the Eskimos are comparable in many ways with Fernald's plants.—**C. Stuart Gager** and **A. F. Blakeslee**: Chromosome and gene mutations in Datura following exposure to radium rays. Sealed glass tubes containing radium emanation were inserted into flower buds of *Datura Stramonium*. The results claimed include an increased percentage of chromosomal mutants, a new compound chromosomal type, Nubbin, and two new gene mutants.—**A. F. Blakeslee**: The chromosomal constitution of Nubbin, a compound ($2n+1$) type in Datura.

Official Publications Received.

BRITISH.

Department of the Interior, Canada. Natural Resources Intelligence Service. Canada as a National Property. Pp. 75+9 maps. (Ottawa: F. A. Acland.)

Society of Chemical Industry: Chemical Engineering Group. Proceedings. Vols. 6B and 7, 1924–1925. Pp. viii+199. (London.)

Navy (Health). Statistical Report of the Health of the Navy for the Year 1924. Pp v+127. (London: H.M. Stationery Office.) 4s. 6d. net.

Annals of Eugenics: a Journal for the Scientific Study of Racial Problems. Edited by Karl Pearson, assisted by Ethel M. Elderton. Vol. 2, Parts 1 and 2, April. Pp. 244. (London: Francis Galton Laboratory for National Eugenics, University College.) 35s. net.

Report of the Oversea Settlement Committee for the Year ended 31st December 1926. (Cmd 2847.) Pp. 30. (London: H.M. Stationery Office.) 6d. net.

Mysore Geological Department. Records, Vol. 24, 1925. Part 2. Pp. v+29-160. (Bangalore: Government Press.) 2 rupees.

Bureau of Education, India. Occasional Reports, No. 14: Some Experiments in Indian Education. Pp. iv+84. (Calcutta: Government of India Central Publication Branch.) 1 8 rupees; 2s. 6d.

British Guiana: Combined Court, Annual Session 1926. Interim Report and Statement of Policy of Geological Survey. By the Economic Geologist and Mineralogist. Pp. 8. (Georgetown, Demerara.)

Publications of the South African Institute for Medical Research. No. 19: Contributions to the Study of Miners' Phthisis. By A. Mavrogordato. Pp. 83+18 plates+12 graphs. (Johannesburg.) 5s.

Deep Level Mining and High Temperatures: an Enquiry into certain Cases of Sudden Death presumably due to Heat Stroke, with a Report on the Associated Conditions. By A. Mavrogordato and H. Pirow. (Reprinted from the *Journal of the South African Institution of Engineers*, Vol. 25.) Pp. 38 (Johannesburg: South African Institute for Medical Research.)

Cocoa: the Story of its Cultivation. Pp. 48. (Bournville: Cadbury Bros., Ltd.)

Seale-Hayne Agricultural College, Newton Abbot, Devon: Department of Plant Pathology. Third Annual Report for the Year ending September 30th, 1926 (Pamphlet No. 21.) Pp. 35. (Newton Abbot.)

The National Physical Laboratory. Watch and Chronometer Trials, 1926. Pp 6. (London: H.M. Stationery Office.) 6d. net.

Journal of the Chemical Society: containing Papers communicated to the Society. April. Pp. vi+iv+687-960 (London: Gurney and Jackson.)

The Quarterly Journal of the Geological Society. Vol. 83, Part 1, No. 329, April 23rd. Pp. xlviii+194+12 plates. (London: Longmans, Green and Co., Ltd.) 7s. 6d.

FOREIGN.

Carnegie Endowment for International Peace. Division of Intercourse and Education. Annual Report of the Director for the Year 1926. Pp. 41+4 plates. (New York City.)

Smithsonian Miscellaneous Collections. Vol. 75, No. 4: Cambrian Geology and Paleontology, V. No. 4: Pre-Devonian Sedimentation in Southern Canadian Rocky Mountains. By Charles D. Walcott. (Publication 2870.) Pp. 147-178. (Washington, D.C.: Smithsonian Institution.)

Department of the Interior: Bureau of Education. Bulletin, 1926, No. 24: An Outline of Methods of Research, with Suggestions for High School Principals and Teachers. Pp. vi+81. (Washington, D.C.: Government Printing Office.) 10 cents.

Travaux et Mémoires du Bureau International des Poids et Mesures. Publiés sous les auspices du Comité International par le Directeur du Bureau. Tome 17. Pp. vi+240+142+96+4. (Paris: Gauthier-Villars et Cie.)

Ministry of Finance: Control of Printing. Almanac for the Year 1927. Pp. ix+853. (Cairo: Government Publications Office.) 7 P.T.

Travaux de la Section de Géodésie de l'Union Géodésique et Géophysique Internationale. Tome 3: Rapports nationaux sur les travaux exécutés dans les différents pays présentés à la deuxième assemblée générale, Madrid, 24 septembre—8 octobre 1924. 19 rapports. (Paris.)

Journal of the College of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol. 16, Part 5. Beitrage zur Entwicklungsgeschichte der Reptilien. 1: Die fruhesten Entwicklungsvorgange bei der Waldeidechse (*Lacerta vivipara* Jacq.). Von Tetsuo Inukai. Pp. 125-201+14 Tafeln. Vol. 16, Part 6: Studies on the Sauropsid Chromosomes. 1: The Sexual Difference of Chromosomes in the Pigeon. By Kan Oguma. Pp. 203-227+plates 15-16. (Sapporo.)

Department of Commerce: Bureau of Standards. Technologic Papers of the Bureau of Standards, No. 335: Thermal Expansion of Graphite. By Peter Hidnert and W. T. Sweeney. Pp. 223-230. (Washington, D.C.: Government Printing Office.) 5 cents.

CATALOGUES.

The West Indies: being a Catalogue of Books, Maps and Engravings, relating to British and Foreign Possessions in the West India Islands. (No. 406.) Pp. 42. (London: Francis Edwards.)

Akehurst's Sub-Stage Condenser Changer. Pp. 6. Shop Soiled Apparatus at Reduced Prices. Microscopes, Objectives, Binocular Dissecting Microscopes, Photomicrographic and Projection Apparatus, Cameras, etc., also Second-hand Apparatus. Pp. 28. Fodis Photographic Distance Meter. Pp. 1. Micro-scope Objectives. Pp. 1. Leitz Binocular Microscope. Pp. 2. Ogilvy Elementary Microscope. Pp. 2. Brinnell-Ogilvy Microscope. Pp. 2. Leitz 'Leica' Roll Film Camera. Pp. 4+4. (London: Ogilvy and Co.)

Diary of Societies.

SATURDAY, MAY 14.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Yorkshire District Meeting) (at Town Hall, Cleckheaton), at 2.

PHYSIOLOGICAL SOCIETY (in Department of Physiology, Cambridge), at 2.30.—Demonstrations: Crystals of Hæmoglobin in Intracorpuscular Environment, N. Henderson and G. N. Spencer; Bodies related to Hæmoglobin in Vegetable Food Stuffs, D. Keilin; The Preparation of Hæmoglobin and its Analogues from their Constituents, R. Hill; Auto-oxidation of Plasma in Anæmia, Dr. Litarczek and Dr. Stromberger; The Extra Cutaneous Spleen, Prof. J. Barcroft; The Dissociation Curve of CO Hæmoglobin, W. H. Forbes; Apparatus for Measurement of Difference in Potential on two Sides of a Membrane, G. S. Adair; Vital Staining in Living Blood Cells, L. J. Witts and R. A. Webb; The Influence of Relative Proportions of Antigen and Antibody on the Formation of a Precipitate, Prof. H. R. Dean and R. A. Webb; A New Method for Subjecting Developing Organisms to

Temperature Gradients, with some Results on the Development of the Frog, M. Shaw, J. Dean, and M. Tazelaar; Dowling's Electric Micromanometer Adapted to Physiological Purposes, H. J. J. Braddick and B. G. King; A Simple Capillary Electrometer and Recording Camera, Dr. E. D. Adrian; The Discharge of Impulses in the Optic Nerve with Moving and Stationary Visual Fields, Rachel Matthews and E. D. Adrian; The Process of Ovulation in the Rabbit, J. Hammond and A. Walton; (a) Some new Ice-action Velocity Apparatus, (b) The Thermal Measurement of the Rate of Buffering of Acids by Proteins, Prof. H. Hartridge and F. J. W. Roughton.—Communications:—A. N. Richards and J. B. Barnwell: Experiments concerning the Elimination of Phenolsulpho Phthalein by the Kidney.—Sir E. Sharpey-Schafer: On Recovery of Sensation after Severance of Cutaneous Nerves in Man.—J. G. Dusser de Barenne and G. C. E. Burger: A Comparison of the Respiratory Exchange in Man during Static and Phasic Work.—Dr. J. O. Wakelin Barratt: The Action of Hirudin upon Thrombin.—I. de Burgh Daly: A Method of Measuring Small Changes in Electrical Capacity and its Application to the Measurement of Blood Velocity in Closed Tubes.—T. R. and W. Parsons: (a) Oxidation of Serum Constituents; (b) Lipoid-Protein Complexes.—T. Lewis and H. M. Marvin: A Postganglionic Axon Reflex in Human Skin.—L. E. Bayliss, E. A. Muller, and Prof. E. H. Starling: New Determinations of the Respiratory Quotient of the Heart-Lung System.—P. De and W. E. Dixon: Quinine Anaesthesia.—W. E. Dixon and J. H. Wadia: The Action of Thallium on the Skin.—W. A. H. Rushton: The Dependence of the Threshold for Nervous Excitation upon the Position of the Electrodes.—A. R. Fee and A. Hemingway: The Oxygen Usage of the Kidney.—J. Needham: Insulin in Embryogenesis.—B. G. King: Relation of Coronary Outflow to the Length of the Cardiac Cycle.—R. S. Stacey: Relation of Coronary Outflow to Heart Volume.—E. Pesarico: Effect of Anoxaemia upon Systematic Blood Vessels.—Prof. H. Hartridge and F. J. W. Roughton: The Rate of Buffering of Acids and of Alkalies.—H. Dryerre: The Effect of Successive Injections of Adrenaline upon the Perfusion Rate.

Royal Society of Medicine (Balneology and Climatology Section) (Annual Provincial Meeting) (at Llandrindod Wells).

SUNDAY, May 15.

Royal Society of Medicine (Balneology and Climatology Section) (Annual Provincial Meeting) (at Llandrindod Wells).

MONDAY, May 16.

Cambridge Philosophical Society (in the Botany School, Cambridge), at 4.30.—Dr. J. Needham: The Carbohydrate Metabolism of the Developing Frog Embryo.—O. M. B. Bulman: Some Structural Characters of the Genus Dictyonema, Hall, and the Technique Employed in their Determination.—J. S. Yeates: Some Problems in the Comparison of Chromosomes.—*Papers to be communicated by title only*:—M. Abeloos: Les théories de la polarité dans les phénomènes de régénération.—Dr. F. H. A. Marshall: The Conditions Governing Parturition.—G. R. de Beer: The Mechanics of Vertebrate Development.

Victoria Institute (at Central Buildings, Westminster), at 4.30.—Lieut.-Col. F. Molony: A Restatement of the Argument for Theism from Design.

Railway Club (at 25 Tothill Street, S.W.), at 7.30.—C. N. Anderson: Some Railway Byways.

Royal Institute of British Architects, at 8.—Modern Hospital Planning:—H. Percy Adams: English Hospitals.—L. G. Pearson: American Hospitals.

Royal Geographical Society (at Æolian Hall), at 8.30.—E. H. de Bunsen: Formosa.

TUESDAY, May 17.

Royal Statistical Society (at Royal Society of Arts), at 5.15.—H. T. Elbourne: Trade Association Statistics.

London Natural History Society (at Winchester House, E.C. 2), at 6.30.—C. B. Smith: Notes on Swiss Butterflies.—R. M. Wattson: Pre-Reformational Baptismal Fonts.

Royal Photographic Society (Colour Group), at 7.—Major A. B. Klein: Colour Photography from the Standpoint of the Painter.

Röntgen Society (Annual General Meeting) (at British Institute of Radiology), at 8.15.—Dr. R. G. Canti: An Investigation of the Effects of Beta and Gamma Radiation on Normal and Malignant Tissue Cells Growing in Vitro by Means of the Cinematograph with Demonstrations.—Prof. J. A. Crowther: An Analysis of some Observations on the Action of X-Rays on Drosophila Eggs.

WEDNESDAY, May 18.

Society of Glass Technology (London Meeting) (at University College), at 2.40.—Dr. G. W. Morey and Dr. N. L. Bowen: The Decomposition of Glass by Water at High Temperatures and Pressures.—Prof. G. Gehlhoff: The Brittleness of Glass.—F. Redfern: The New British 15-arm Automatic Suction Bottle Machine.—Standard Durability Tests for Bottles.

Royal Society of Medicine (History of Medicine Section) (Annual General Meeting), at 5.—J. Leveen: Shabbethai Donnolo.—Dr. R. W. Innes Smith: An Unpublished Letter of John Fothergill.

Royal Meteorological Society, at 5.—Dr. H. Jeffreys: Cyclones and the General Circulation.—G. M. Meyer: Early Water-mills in Relation to Changes in the Rainfall of East Kent.—S. Morris Bower: Report on Winter Thunderstorms in the British Isles from January 1st to March 31st, 1920.

Chemical Society (at Royal Institution), at 5.30.—Prof. R. Willstatter: Problems and Methods in Enzyme Research (Faraday Lecture).

Institution of Electrical Engineers (Wireless Section), at 6.—P. K. Turner: A Wireless Works Laboratory.

Electroplaters' and Depositors' Technical Society (at Northampton Polytechnic Institute), at 7.45.—S. Wernick: The Protective Effect of Metal Deposits on Iron.

Royal Society of Arts, at 8.—R. R. Hyde: Industrial Welfare in Great Britain and the United States.

Folk-Lore Society (at University College), at 8.

Royal Microscopical Society, at 8.—F. P. Carrel: A New Development of the Ultra-Microscope.—Prof. R. Ruggles Gates and Dr. J. Latter: Observations on the Pollen Development of Two Species of Lathraea.—J. Lomax: The Preparation and Examination of Coal Sections.

THURSDAY, May 19.

Society of Glass Technology (London Meeting) (at University College), at 2.30.—General Discussion on Furnace Efficiency, in particular on the paper presented by Prof. W. E. S. Turner to the April meeting, namely, A Brief Review of Furnace Developments.

Royal Society, at 4.30.—Lord Rayleigh: Studies of the Mercury Band-Spectrum of Long Duration.—Prof. A. Fowler and L. J. Freeman: The Spectrum of Ionised Nitrogen (N II).—Prof. O. W. Richardson: Note on a Connexion between the Visible and Ultra-violet Bands of Hydrogen.—D. Jack: The Band Spectrum of Water Vapour.

Institution of Mining and Metallurgy (at Geological Society), at 5.30.

C.B.C. Society for Constructive Birth Control and Racial Progress (at Essex Hall, Strand), at 8.—Mrs. H. Earl, Mrs. T. Edmunds, and A. W. Goodman: What converted me to Birth Control and What I should like to see done for the Movement.

Chemical Society, at 8.—Dr. H. M. Dawson: New Developments in the Study of Acid Catalysis: The Catalytic Catenary.

Royal Society of Tropical Medicine and Hygiene (at 11 Chandos Street, Cavendish Square), at 8.15.—Debate on The Organisation of Medical Research in the Tropics, Prof. Warrington Yorke, Dr. A. T. Stanton.

FRIDAY, May 20.

British Psychological Society (Æsthetics Section) (at Bedford College), at 5.30.—Mrs. Ursula Roberts (Susan Miles): The Functions of the Critic.

Royal Society of Medicine (Electro-Therapeutics Section) (Annual General Meeting), at 7.

Royal Photographic Society, at 7.—Pictorial Group Meeting.—R. H. Lawton: Individuality.

Royal Institution of Great Britain, at 9.—Prof. W. L. Bragg: The Structure of the Silicates.

PUBLIC LECTURES.

SUNDAY, May 15.

Guildhouse (Eccleston Square, S.W.), at 3.30.—Dr. D. G. Hogarth: The Hittite People and their Civilisation.

MONDAY, May 10.

Middlesex Hospital Medical School, at 5.—Prof. J. Fraser: Some Surgical Problems. (Succeeding Lectures on May 17 and 18.)

London (R.F.H.) School of Medicine for Women, at 5.30.—Prof. H. Beckwith Whitehouse: The Menstrual Function, its Physiology and Pathology. (Succeeding Lectures on May 23 and 30.)

TUESDAY, May 17.

Gresham College, at 6.—Sir Robert Armstrong-Jones: Physic. (Succeeding Lectures on May 18, 19, and 20.)

Sir John Cass Technical Institute, at 6.30.—Dr. W. H. Hatfield: Special Steels and their Application in Engineering. (Succeeding Lectures on May 31 and June 14.)

WEDNESDAY, May 18.

London School of Economics, at 5.—C. S. Orwin: The Economics of Agriculture. (Succeeding Lectures on May 25 and June 1.)

Royal School of Mines, at 5.30.—U. R. Evans: Oxidation, Corrosion, and Passivity of Metals. (Succeeding Lectures on May 25 and June 1.)

THURSDAY, May 19.

British Medical Association (Tavistock Square, W.C.), at 3.30.—Dr. E. Goodall: Some of the Work done to elucidate the Pathology of Disease falling to be considered under the rubric 'Insanity' (Maudsley Lecture).

London Hospital Medical College, at 4.15.—Prof. K. Faber: Gastritis, its relation to Achylia and Ulcer (Schorstein Memorial Lecture).

Institute of Pathology and Research, St. Mary's Hospital, at 5.—Lt.-Col. S. P. James: Some Methods and Problems of Malaria Research.

FRIDAY, May 20.

Guy's Hospital Medical School, at 5.30.—Prof. E. H. Kettle: Inflammation and Infection. (Succeeding Lectures on May 27, 31, and June 3.)

CONGRESSES.

May 25 and 26.

French Society of Oto-neuro-ophthalmology (at Strasbourg).

June 8 to 9.

Convention of Canadian Chemists (at Quebec).

SATURDAY, MAY 21, 1927.

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University Statistics and Tendencies.

SINCE the comparative tables of statistics before us[1] have been compiled by the University Grants Committee, it is but natural that we should turn first to those which shed light upon the financial position. Nor need we make any apology; for unless that position be sound there can be little expectation that the function of the universities can satisfactorily be discharged. Happily the accounts show a decided and general improvement, particularly when it is noted that only in the case of thirteen institutions has expenditure exceeded income; and even in these cases the deficits were small and were due to the fact that the institutions concerned met out of income an unusual amount of capital or other non-recurrent expenditure.

The improved position is due largely to increased Treasury grants made upon the recommendation of the Grants Committee, and indicates very clearly that that recommendation has been justified. At first glance the increase in "Government Grant," 35·9 to 39·5 per cent., does not appear to be great, but it has nevertheless been an excellent incentive. Not only have the institutions suffering from a deficit been reduced from twenty-four to thirteen, but also, as the Committee points out, there is another gratifying fact which does not appear in the tables: during 1925–26 reductions of debt to the amount of more than £50,000 were effected. This possesses a special significance when it is observed that increases of salaries of teaching staff cost more than £88,000; increases in departmental and laboratory maintenance more than £23,000; in general libraries and museums, £24,000; in repairs and maintenance of buildings, £38,000; in capital expenditure met from income, £57,000; and in grants to students' societies, £10,000. The increase of government grants was not, of course, wholly responsible. Income from local education authorities, from endowments, donations, subscriptions, and students' fees, was, in each case, greater than in the preceding year.

With regard to the number of full-time students it may be said that the year has shown a return to what may be normally expected. Actually there is a slight decrease from 41,794 in 1924–25 to 41,443 in 1925–26, but this is largely accounted for by the fall in the number of ex-service students from 263 to 17. Any small aggregate decrease in the number of full-time students is not, as the

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[1] University Grants Committee. Returns from Universities and University Colleges in receipt of Treasury Grant, 1925–1926. Pp. 24 (London: H.M. Stationery Office, 1927.) 3s. net.

Committee points out, very surprising in view of the prolonged industrial depression; and against that small decrease must be set an encouraging increase in the number entering for the first time upon degree or diploma courses.

Whatever may be the numbers of students, the main interest must be concentrated upon what they are doing; and here there emerge facts which at present we shall not attempt to explain, since they depend upon conditions which are more or less familiar to us all. In the medical, technological, and agricultural groups there is a fall, the decreases being 1000, 152, and 70 respectively. In the pure science group there is a slight increase, while in the arts group there is the substantial increase of 869. As to what specific subjects are proving more or less popular, however, the Committee finds it difficult, for obvious reasons, to carry its analysis far enough. It realises, nevertheless, that it is possible for certain subjects to become rather more popular than is desirable in the national interest. Is philosophy, for example, "not tending to be unduly neglected by our arts students"? Or is chemistry "not tending to attract an unduly large proportion of our science students"?

For our part we do not lack evidence to show that chemistry is, at present, attracting a number of students which may be unduly large. But on the question as to whether this is a matter for alarm or congratulation we do not propose to speak at the moment. We do, however, regret the tendency —and we cannot fail to note that in this age of specialisation it must inevitably increase—for students to neglect philosophy. Nor would we confine that regret solely to the fact that it is neglected by arts students. Philosophy is not the monopoly of any particular group: it is an essential to every student. Let there be no mistake. We are not thinking of it as a form of metaphysics down the tangled by-paths of which we would have science students lose themselves. But if science means, ultimately, an enlargement of experience, we regard philosophy as a critique of that experience.

If we appear to over-emphasise this point in connexion with the courses—in arts or science—of university students, let our excuse be that we claim a lofty view of the function of a university —a view which made us sympathetic, some three or four years ago, with the writer of an article in a prominent university magazine. "Let us learn from others and make our own peculiar gift to the common stock of undergraduate life. If, however, we are not prepared to do this, then let us at least be honest and call ourselves first-rate teeth-extractors, assiduous engine-wipers, and the like, but not 'varsity men."

This matter of the actual subjects followed by university students leads us directly to another important aspect which the present Committee's returns place before us. The whole documen seems to us to fall into three main parts: that dealing with accounts, the congratulatory nature of which we have already indicated; that dealing with the subjects and groups of subjects which are being followed in the universities; and that dealing with a matter upon which there is, as yet little reason to regard as satisfactory. We refer to university libraries. In this connexion a new table of figures has been introduced into the Returns before us. In its general reports in 1921 and 1925 the Committee reminds us, not only was great stress laid upon the importance of well-equipped libraries, but their maintenance and developmen was insisted upon as one of a university's primary duties, "since defects in this central organ must inevitably have a harmful effect upon the work both of teachers and of students in all departments alike." But the state of affairs revealed by the Library Table, in spite of the fact that a larger sum was spent in 1925–26 than in the preceding year still presents "an essentially gloomy picture."

In the universities of Great Britain (excluding Oxford and Cambridge) the total expenditure on libraries was £120,616. This sum was made up of £46,280 (salaries), £58,237 (books), £8946 (binding) £7153 (ordinary upkeep). The amount spent upon books by more than fifty institutions of university rank is astonishingly small, and while the Committee is not unaware of the difficulties which beset comparisons between our university conditions and those of other countries, it does not hesitate to justify its phrase "an essentially gloomy picture" by comparison with the United States. We cannot improve the wording of the Committee: ". . . we could not escape some rather melancholy reflections at finding that for the item of expenditure on books during the academic year 1925–26 the total figure for all our grant-aided universities and colleges put together appeared to be little larger than the combined figure for the universities of Harvard and Yale. . . ."

We said above that our reflections concerning the neglect of philosophy led us directly to the important aspect which the returns show us of university library conditions. We do not imagine that, for those who share our views as to the function of a university, any further explanation is needed.

Physical and Chemical Tables.

International Critical Tables of Numerical Data, Physics, Chemistry and Technology. Prepared under the Auspices of the International Research Council and the National Academy of Sciences by the National Research Council of the United States of America. Editor-in-Chief: Dr. Edward W. Washburn. (Published for the National Research Council.) In 5 vols. Vol. 1. Pp. xx+415. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1926.) Sold in sets only, 12 dollars per vol.

THE volume under review constitutes the first of a series of five volumes of critical tables of numerical data relating to physics, chemistry, and technology. They have been prepared under the auspices of the International Research Council and the U.S. National Academy of Sciences by the National Research Council of the U.S.A., with Dr. Washburn as editor-in-chief. Dr. Washburn has worked through the agency of ten corresponding editors and advisory committees in the leading countries of the world, except Germany.

The bulk of the contributors to the first volume are American; of the fifty names mentioned, thirty-four are American, seven British, three French, two Austrian, two Danish, one Dutch, and one Japanese. The nomination of contributors from Britain was left in the hands of a committee composed of Dr. Kaye (editor), Sir Robert Robertson, Dr. Rosenhain, Prof. Porter, Dr. Stanton, Mr. Sears, Mr. Egerton, with Mr. Higgins as secretary.

Some idea of the magnitude of the venture may be gained from the fact that the editorial, contribution, and manufacturing costs have been appraised at 570,000 dollars. The price per set is 60 dollars, but a special pre-publication offer at 35 dollars per set was made, which brought in orders for nearly 6500 sets. It is interesting to note that only twenty per cent. of these orders came from countries outside the United States, although 150,000 announcements of the offer were mailed to all parts of the world. If any conclusion can be drawn from this return, it is that in the United States there is a large public which can appreciate the value of such an undertaking and has also the purchasing power to acquire copies. The publication of these Tables at a price that would make possible a world-wide distribution, required that the project should be financed by those realising its importance and in a position to make the necessary investment. Some 244 American firms and individuals, and two of the larger foundations, have provided the sum of 170,000 dollars required for the compilation.

If we may judge the entire work by the standard of the volume under review, then we may say that this work is likely to be of incalculable value to scientific and technical workers, and the organisers and 300 experts have rendered a signal service to mankind by their co-operative effort to render readily accessible the enormous accumulation of data.

It is only when one reflects that until the middle of the last century no attention had been given to the accurate determination of physical and chemical data that one appreciates the tremendous advance that has taken place. In science the accumulated facts make for progress, but the rate at which data are piling up at the present time is such that, unless a systematic effort is made to cope with it, there is a likelihood of a vast amount of human labour being frittered away in unnecessary duplication.

Scanning over the four hundred or so pages of this volume, packed with carefully analysed data, one cannot but marvel at the immense industry of the scientific workers both past and present who have toiled with but one goal in view—the measurement with the highest precision of a physical or a chemical constant.

The dawn of this era of exact measurement was heralded in by a galaxy of mighty experimentalists, amongst whom Stas, Dumas, and Regnault stand out pre-eminently. One recalls the resourcefulness of Stas, who, in order to prepare silver of the highest purity, boldly undertook the task of distilling this metal; the painstaking care of Dumas, who, when making his experiments on the gravimetric composition of water, frequently started an experiment at daybreak and did not see its completion until the dawn of the following day; the meticulous accuracy of Regnault, who, in order to preserve his data, engraved directly on a sheet of polished copper his experimental points and the mean curve through them.

These old pioneers have had worthy successors endowed with added knowledge and the development of fresh instruments. The primary object of these critical tables is to harvest fruit of their toil, sorting the wheat from the chaff, for the benefit of civilisation.

It would be presumptuous to criticise a work such as the volume under review. All one can attempt to do is to offer a few friendly suggestions that might help to make the volume of still greater utility when a further edition is called for.

One feature of the book which immediately impresses the reader is the mechanical perfection of the 'set up.' The arrangement of the tables and the selection of the various sized type leave nothing to be desired. One must, however, point out that the only full-page graph in the volume (page 33) is one which it is impossible to use with comfort. It would have been advantageous to have the data in the form of a nomogram.

The volume opens with a section on national and local systems of weights and measures. The reader can derive much amusement from a study of these; for example, on page 10 the Persian unit of 1 guerze is given as 0·63 m. to 0·97 m.; such elasticity in a unit probably fits in with Eastern notions of buying and selling! It is also of interest to learn that the sacred cubit differs quite considerably from the common cubit. The compilation of this table, occupying fifteen pages, must have involved an immense amount of searching on the part of the compilators.

This is followed by a section on conversion factors and dimensional formulæ. These factors are well arranged and complete, but one does not find a conversion factor familiar to all concerned with thermal conductivity work, namely, for converting thermal conductivities expressed in gram calories per sq. cm. per sec. for 1° C. difference into B.Th.U.'s per sq. ft. per hour for 1 inch thickness and 1° F. difference in temperature. One would like to see B.Th.U. used for British Thermal Unit instead of B.T.U., which is apt to lead to confusion with the Board of Trade electrical unit. Many people prefer to make conversions with the aid of diagrams, so it would have been helpful if reference were made in connexion with this table of conversion factors to the existence of a collection of forty-three graphic tables for the conversion of measurements in different units compiled by R. H. Smith and published in 1895.

We feel that the utility of these volumes could be increased if especial attention had been given to indicate the location of special tables the importance of which is not such as to justify their inclusion in these volumes. For example, it may not be generally known that the annual reports of the British Association contain tables of Bessel functions, sines and cosines of angles in radians, logarithmic Gamma functions, etc., and that the Physical Society has published a table of hyperbolic sines and cosines. Then, again, there is the useful collection of physical and chemical data of nitrogen compounds prepared by the Munitions Inventions Department during the War.

The definition of selected terms occupies nine pages.

We are rather astonished to learn that the Hefner unit is obsolete. Probably the wish is father to the thought! The Hefner is the only official standard for the whole of Germany and has more statutory significance than the standards of Great Britain. As regards the definition of the candle, the author might possibly have expressed himself a little more clearly. It is a unit that is maintained at certain national laboratories in terms of electrical incandescent lamps.

The section on "The Structure of the Isolated Atom" partakes more of the appearance of a scientific paper than the pages of a highly condensed book of reference. Many will question the advisability of quoting Table 2, page 49, from Bohr's book, especially when the subject is in such an unsettled state. It might be noted that Stoner has calculated a table which differs from that given in Table 2. Incidentally, there is a misprint in the middle of this table, 8 being printed instead of 2. The full-page diagram of the normal orbit of the outer electron on page 51 is of more academic interest than practical utility. But the diagram on the preceding page of maximum elongations of electrons of several groups may prove useful in working out optical properties.

The section on resistance thermometers under the main heading "Thermometry" is all too brief. One would like to have found there a table of *t* and *pt* to facilitate calculations in the same way as one finds under "Thermocouples" standard tables of temperature and thermo-electric force.

To British ears the statement that "The Callendar equations were devised to facilitate computations by the method of successive approximations" will sound a little strange, even if it is strictly true. It would have been helpful if the writer of the article had indicated the sources where platinum of the requisite degree of purity was obtainable, as it is rather difficult to secure material which complies with the specification he quotes.

In connexion with the article on temperature measurement, it might have been appropriate to point out that certain laboratories supply materials of certified melting points or boiling points which can be used for calibration purposes. A range of pure metals is available for high temperatures and organic compounds for low temperatures.

To the section on optical pyrometry the addition of a table of the emissivities of various substances and a reference to the very detailed charts based on computations from Wien's Law issued by the

Bureau would have been useful. Total radiation yrometry is not dealt with.

The section on laboratory methods for producing and maintaining constant temperatures should prove of considerable service. The addition of one mixture may be suggested, namely, crushed ice and fuming nitric acid, by means of which − 30° can be obtained almost instantly. A reference to the article on the production of cold in the *Journal of he Optical Society of America and Review of Scientific Instruments* would be helpful to the reader.

It is difficult to understand the editor's motives or placing the section "Standard Buffer Solutions and Acid-Base Indicators" in Vol. 1, for they could most appropriately accompany other electrochemical data on ionisation, etc. Wedged at present between a section on "Volume of a Mass of Liquid of known Weight in Air" on one side and "High Vacuum Technique" on the other, it seems out of place.

In the section on "High Vacuum Technique," one might suggest that a note be made to the effect that the expression for the rate of flow of gas through a tube is applicable to within five per cent. only up to a pressure when the free path of the gas molecule is 0·4 times the bore of the tube. No mention is made of Knudsen or of his general equation connecting the rate of flow with the dimensions of the tube. The formula for the molecular flow through a circular opening is not quite correct; it should be $W = \frac{3\cdot192}{d^2}$; the arithmetical slip occurs in Dushman's original paper.

In the table giving data on various types of pumps, it might be noted that the Gaede molecular pump referred to is now obsolete; no mention is made of the Holweck pump. It is probable that a slip has crept into the table giving pumping speeds of various types of pumps and that the figures in the last line refer to the three-stage Gaede steel pump, for the recently introduced two-stage steel pump will not function against a back pressure of 20 mm. The value 60,000 quoted for the performance of this pump is not one which can be obtained under the usual conditions of operation. It is also rather surprising that no information is given concerning the gauges employed for measuring the pressures. Experience has shown that the normal upper limit of the ionisation gauge is 1/1000 mm., while the Pirani cannot well be employed for pressures below this.

We suggest the addition of a table giving the nature and amounts of various gases to be expected from various typical glasses, metals, and silica when heated *in vacuo*. The reader would also have been glad to know that, in addition to the substances mentioned, red phosphorus can be used with glass apparatus for removing the residual gas. Other additions which may be suggested are (*a*) a table of the vapour pressure of the oils used in pumps; (*b*) a table of the expansion coefficients of glasses and metals suitable for sealing in to glass with tolerance limits.

On page 102, in the table entitled "Elementary Substances and Atmospheric Air," there is a misprint in the value quoted for the viscosity of air. It should be 180·8, not 284·2.

The most important table in the volume is labelled § Table, extending over 55 pages, and gives the important constants of chemical compounds. A point of criticism in regard to this is the order of accuracy to which the molecular weights are given; for example, TiO_2 79·9000, MnF_2 92·9300, $Al(OH)_3$ 77·9831, LiH 7·94670. One wonders what justification there is for the number of significant figures quoted. Yet it is stated on page 98 that the values given are approximate, and it is proposed to give more accurate values in subsequent sections. A second point is whether some of the substances to which formulæ are ascribed are true compounds; for example, $66PbO,21As_2O_5,12H_2O$, 19552·5. Possibly this and countless others are merely 'solid solutions.' No literature references are given in this table.

On page 165 there is a table of refractive indices of numerous compounds, but not of the fundamental elements. It would have been advisable to include the table published in Finnish by J. A. Wasastzerna on ionic refractivities.

On page 357 one finds a section on "Sweeting Agents and Odoriferous Materials" sandwiched between "Dispersoidology" and "Radioactivity"!

Many will feel disposed to question whether the tables on the properties of stars—their distribution and their motion—are physico-chemical data. If astronomical data are to be included, a reference might be given to Brown's tables of the moon, which embodies the results of thirty years of mathematical investigations of a high order. Possibly some day similar tables will become available for the minor planets or asteroids, of which about a thousand are known. Encouragement might thus be given to such monumental pieces of calculation by a reference in a standard book.

The table on X-ray diffraction data from crystals and liquids, page 338, is remarkably complete, but some indication of the accuracy of the data in the unit cell column is desirable. This subject is advancing at such a prodigious rate that, even in the short time which has elapsed since its publication, quite a formidable array of substances has received investigation in the intervening period. We may mention the following: TiO$_2$ (anatase), ZrSiO$_4$, SnO$_2$, MnO$_2$, MnF, CaSO$_4$, CaWO$_4$, CaMoO$_4$, BeAl$_2$O$_4$, Be$_3$Al$_2$Si$_6$O$_{18}$.

The compilation of the section on aerodynamics, page 404, must have presented unusual difficulties on account of the wealth of material available. It would be advisable in Table 2 on page 404 to indicate that V_t means either feet per second or metres per second, according to whether one is reading to the right or the left. Fig. 9 has a misprint in the letterpress; the word Riabouchinski is incomplete. On page 410 (foot of second column) the statement concerning the effect of adding fins might be a little more explicit. It states that adding fins greatly increases the drag of streamline solids; the effect of the fins on the airship R33, for example, put up the drag by eight per cent. The percentage effect would of course be greater if the hull alone was considered.

The reviewer must stress the fact that the various points raised in his review detract little, if anything, from the value of this splendid piece of work. All busy workers are under a profound debt of gratitude to the various experts who have collaborated to produce this unique collection of tables. The best way in which the user can show his appreciation is to indicate to the editors where he considers improvement possible, so that we may look forward to later editions which will embody the best that science has achieved.

The task of compiling this monumental work has obviously necessitated much serious study on the part of the corresponding experts, and, by bringing to bear their critical judgment on the literature, they have discovered serious lacunæ and contradictions. An excellent illustration of this will be found in an article by Bichowsky in the *Journal of Industrial and Engineering Chem.* for April 1926, entitled "The Data of Thermochemistry." There he points out discrepancies which appear in tables generally accepted as standard. As examples he cites Al$_2$S$_3$, the value for which given in the tables should be multiplied by 2, while in the case of Fe(NO$_3$)$_3$ the quoted value should be halved, and numerous other inconsistencies. Again, Washburn, in an address delivered before the American Association for the Advancement of Science, December 1924 (published in *Science*, Jan. 16, 1925), points out "Some Effects of the Atmosphere upon Physical Measurements" and cites numerous examples fallacies.

The same state of affairs probably exists in regar to some others of the constants scrutinised, and would serve a very useful purpose if the exper would publish their findings independently and i greater detail.

EZER GRIFFITHS.

Mechanism and Vitalism.

(1) *Die anorganischen Grenzgebiete der Biologie (insbesondere der Kristallvergleich).* Von Hans Prz bram. (Sammlung Borntraeger, Band 10.) P 240. (Berlin: Gebrüder Borntraeger, 1926 7·50 gold marks.

(2) *Man not a Machine: a Study of the Finalisti Aspects of Life.* By Prof. Eugenio Rignan (Psyche Miniatures: General Series, No. 3 Pp. 77. (London: Kegan Paul and Co., Ltd 1926.) 2s. 6d. net.

THE perennial conflict between the mechan istic and the vitalistic views of life i illustrated by the two books before us. Pro Przibram endeavours to persuade us that livin beings are governed by the same laws as thos which regulate the structure and growth of crystal whilst Prof. Rignano, the distinguished editor *Scientia*, is equally certain that the phenomen which subjectively we recognise in our consciou life as memory, are characteristic of all life and affor the most fundamental explanation of the livin process. It is somewhat surprising that Przibram who has a European reputation as an experimenta biologist, should be the champion of the mechanisti view, and that Rignano, who was trained as physicist, should espouse the cause of vitalism.

The comparison of living beings to crystals is on that has often occurred to the minds of biologists because crystals, like organisms, have a specifi form which they preserve, with minor modifications as they grow; but the difficulties of this compariso are obvious, and until now have appeared insuper able. Crystals grow by accretions to their oute surface; organisms by the interposition of new living molecules amongst those already existing The additions to the body, like those to crystals come from the surrounding medium, but the molecules added to a crystal exist as such in the mothe liquor and are merely precipitated on the crystal' surface, whereas those that build up the organism are elaborated by the organism itself out of simple ones which it takes in as food. The crystal is mass of similar molecules, whereas the organism i composed of different chemical substances arrange n a definite manner so as to build up a structure which will work

(1) With extraordinary ingenuity and perseverance Przibram sets himself to surmount these difficulties. He begins by pointing out that although iving substance always appears in the form of a colloid whereas crystalline substances are solids, yet almost any crystalline salt can be made to appear as a 'colloid' consisting of a number of minute crystalline particles suspended in the mother iquor. The form in which it will appear depends on its concentration in the solution and the rapidity of evaporation. Further, whilst it is true that in he most familiar crystals growth only occurs at the surface, yet there exist 'fluid crystals' and crystals like those of hæmoglobin and similar organic substances which can imbibe water and in which therefore new molecules can be interposed between those already existing; in these cases Przibram holds that "growth by intussusception" may be said to occur.

The objection that a crystal consists of a repetition of similar molecules is met by what we must regard as a quibble on Przibram's part. He says that molecules do not exist as such in crystals, because all are united in a common lattice-work of atoms, and therefore in going from point to point in a crystal we encounter alternations of different kinds of atoms; and this alternation he compares to the mixture of distinct chemical substances ound in all living matter.

With regard to the assimilation of food, Przibram makes a brave attempt to find something like it in crystals. He points out that in certain cases where an optically inactive substance is present in a solution, the presence of a crystal of the dextral or sinistral variety will determine the precipitation of this variety of the substance on the surface of the crystal. Further, when two salts crystallising in somewhat similar forms are mixed in a solution, alternate layers of each may be deposited on the crystal.

Postponing for the moment the question whether or not these analogies are sound, let us look at what Przibram considers the gains of his point of view. He points out that a broken crystal 'regenerates' the missing part, just as many (not all) animals can regenerate an amputated limb; that in some substances the molecular lattice-work is capable of building itself up on alternative forms: thus, substances belonging to the first crystalline system can form cubes or octohedra, and these two forms may tend to appear in the same crystal and thus compete with one another, so that cubes with truncated angles are often observed. The form which will ultimately prevail is that which grows most slowly, for this requires less material for its realisation; the quickly developing form appears first, but its growth comes to a stop for scarcity of the necessary 'food.' This Przibram compares to the cases where an antenna of an insect is replaced by a leg, a phenomenon termed by the late Dr. Bateson 'hamœosis.' He maintains that the form of the regenerated part depends on the arrangement of the 'lattice-work' of the surrounding tissue; thus the formation of limbs from transplanted rudiments in Amblystoma, as evidenced by his own repetition of Harrison's experiments, is governed by the structure of the skin surrounding the rudiment and not by the relation of the new organ to the 'whole,' as Driesch has asserted. He shows that two fluid crystals will coalesce into one as do two blastulæ of Echinus, and he says that Driesch's conundrum of the impossibility of conceiving a machine which by division will give rise to two similar machines is answered by the lattice-work of a crystal, for this if broken into two will regenerate two similar crystals.

We recommend this work of Przibram to the careful attention of all our readers; they will find it a mine of information on the physics of crystals, though it is to be regretted that he only mentions Sir William Bragg's name once, and no one would gather from a perusal of the book that we owe nearly all our modern knowledge of crystal structure to Bragg's discoveries.

Przibram has, however, failed to convince us of the validity and worth of the comparison of the structure of living beings with crystals, and if he with all his knowledge of biology has failed, no one else is likely to succeed. To give a detailed destructive criticism of all his arguments would occupy too much space, but some of the principal objections which occur to us may be noted. Thus it is misleading to compare a colloid solution of an inorganic salt such as ferric chloride with the colloids of living bodies. The former is a suspensoid—really a minutely divided precipitate—the latter a diphasic or even triphasic emulsoid of different fluids enclosing one another, and the physics of the two states are, as Hardy has shown, quite different. The citation of fluid crystals is irrelevant. The term 'fluid crystal' is a misleading one to denote an intermediate phase between complete fluidity and definite crystallisation which is exhibited by certain organic substances. In this condition—stable over only a narrow range of temperature—the molecules of the substance roll over one another, so that it is a fluid, but these molecules are sufficiently close to exert such an influence on one another as to keep their optical axes parallel. It is really a drop of turbid fluid, of which the turbidity is due to crystalline particles. The fundamental objection, however, is that a crystal is a relatively static form of material, whilst every particle of a living being, so long as it is alive, is in a continual state of destruction and reconstitution, and this reconstitution is effected from relatively simple materials. Nothing at all similar to the miracle of assimilation is to be found outside the domain of life.

(2) It is with this miracle that Rignano begins his book "Man not a Machine." The building up of new protoplasm from food he regards as one example of that 'purposeful striving' which is the inner nature not only of man but also of all life. In this case it is a striving to maintain a certain dynamic equilibrium. Prof. Leathes in his address to the Physiological Section of the British Association last summer pointed out that, given the known compounds into which food is broken by digestion, the number of ways in which they could be strung together runs into countless millions of millions, and yet they are put together in one particular way and no other. Rignano goes on to show that ontogeny, or the development of the individual, is likewise a striving to reach a typical end. It was indeed the recognition of this fact, and of the tendency of the egg to reach this end even when mutilated, by the adaptation of parts to purposes to which in normal circumstances they never would be put, which converted Driesch from being an adherent of Weismann to a vitalistic position.

The whole life of an organism and its movements are, as Rignano asserts, one continued striving to maintain around it the accustomed environment. When living matter is exposed to a new environment "it has no rest until it has either re-established the old environment or becomes adapted to the new one," that is, until it succeeds in establishing a new equilibrium. Adaptation to a new environment is attained by a constant series of trials—but when once it is attained the reappearance of the same conditions call forth the successful response with ever-increasing rapidity. It is this peculiarity of living matter which Rignano calls memory and which accounts for the inheritance of acquired characters. It corresponds to what the reviewer has elsewhere called 'habitudinal memory.' Rignano tries to explain it by his theory of 'specific accumulation,' which is at any rate a plausible one. It is to the effect that every reaction leaves behind it in all the nuclei of the reacting animal a deposi or trace, the effect of which is to accelerate th production of the same reaction when the sam circumstances recur. The continual reaction to stereotyped situation becomes a reflex or instinct and the reflex is thus not the primary building ston out of which the actions of an animal are built up as many physiologists have supposed, but merel the result of long-continued repetition.

The application of these principles to the life o man occupies the last chapters of the book. Fo the detailed criticism and analysis of these chapter we have no space, but we can sum up the controversy between vitalism and mechanism somewha as follows. *All scientific reasoning is comparison* starting with what is relatively known and familia or with what we imagine to be so, and we strive t compare with it the more complicated and unfamiliar. The mechanistic biologist, taking a familiar the chemical reactions which go on in test-tube, seeks to reduce the life around him (an incidentally his own) to a combination of these determined by the juxtaposition of unlike substances, that is, by structure. The vitalist is impressed with the most thrilling of all the facts i biology, namely, the fact that he himself is alive The life of this one being he knows from th inside, and he thinks it logical to compare wit this life the life of other beings, so that a certai measure of qualified anthropomorphism seems t him to be the only rational way of dealin with life.

After all, it is doubtful whether in the last reso Przibram seriously regards himself as a magnifie crystal, and, as Dr. Broad has recently said, "th man who asserts that his brother—or his cat—i merely a mechanism, is either a fool—or a physio logist." Dr. Bateson once said: "If to be a vitalis is to admit that here and now we cannot explai the actions of living beings by physics and chemistry, who would not be a vitalist?" It may b held that to accept any form of vitalism is t sterilise biology and that only the mechanisti hypothesis leads to results; but in zoology, at an rate, this is not true. In studying the physics an chemistry of the cell we are studying the tools life, not life itself, and 'mechanistic' theories heredity have only led to the creation of a welte of incomprehensible 'genes,' the nature an origin of which are mysterious: real light o the inner nature and evolution of animal life ha only come from following the lead of the concept of striving, habit and memory.

E. W. M.

Our Bookshelf.

The Memory Factor in Biology: a Sketch of the Unity of Life. By Prof. C. J. Patten. Pp. xiii + 175. (London: Baillière, Tindall and Cox, Ltd., 1926.) 5s. net.

PROF. PATTEN is an enthusiastic supporter of the mnemic theory of life and heredity which is associated with the names of Hering, Samuel Butler, Francis Darwin, and Semon. His little book is very readable and contains much matter within a small compass. The theses put forward are "that Memory is indeed the Mainspring of Organic Evolution, and also that it is the source and potentiality which unifies both consciously and unconsciously the Psychic side of all living organisms; that vital activities, morphological as well as physiological, are in truth Psychic manifestations; that even the simplest vital activities are quite purposive; that Memory is rhythmic in character; that the processes at work in the evolution both of the Individual and of the Race furnish evidence of being an unbroken chain of Memory Processes, and are, in the main, due to Habit Formation; and lastly, that Memory Processes, when analysed mainly in regard to their physical basis, cast a strong beam of light upon the advocacy of Somatic Inheritance" (p. xii).

One might conclude from this citation that Prof. Patten is a psychobiologist, and indeed he comes very near to that position. On one cardinal point he is quite emphatic, "that unless one postulates the presence of a Psychic side in all living things any attempt to explain Memory phenomena on rational lines would signally break down" (p. xi). But the philosophical position he adopts is apparently that of monism, of the rather vague Haeckelian kind, which is by no means free from the dualistic taint that Prof. Patten has in horror. So it comes about that in elaborating the memory theory he falls back upon the "physical trace" or "engramm" conception of Richard Semon: he tries, in other words, to translate what is essentially a psychical activity into its presumed physical correlate.

For our own part we hold with James Ward that a memory theory of heredity will not work unless based frankly upon a psychological theory of life, and freed from the mechanistic preconception of physical traces. But it must be confessed that no one as yet has successfully worked out such a theory.

E. S. R.

Industrial Fermentations. By Prof. Paul W. Allen. Pp. 424. (New York: The Chemical Catalog Co., Inc., 1926.) 5 dollars.

PARAPHRASING the author's statement in his preface, this book is not intended for those who require special knowledge on the subjects it deals with, but its intention is "to bring together in a general way some of our present information concerning the application of micro-organisms to industry." Taking this fully into account, after having read the book, we must confess ourselves disappointed. The text is divided into thirty-one chapters, each dealing with some special applications of micro-organisms to industrial processes. To those who are acquainted with only some of these processes, the task of giving even a general account of so wide a field in so small a compass will appear at once Utopian.

The book contains useful information, but a perusal of the text justifies our criticism. Under "Leather and Tanning" the processes preceding the tanning are described briefly but accurately, whilst tanning itself occupies but twelve lines; and here there is no mention of the use of tannin extracts, or of chromium compounds, formaldehyde, etc., treatment of the hide or skin with a mixture of fish and other oils only being referred to. Bread-making occupies forty pages and gives some useful outlines of the processes employed. We are left in doubt, however, as to the meaning of the following sentences (p. 133): "The particular kind of yeast which is of interest to the bread maker is Saccharomyces cerevisiæ. . . . These organisms are divided into three groups: bottom yeasts of German beers, top yeasts used in making English beers, and distillery yeasts. . . . These are the yeasts generally used in the manufacture of bread." If the author refers to all three, his statements are incorrect. Nor do we obtain any further help in this connexion in the chapter on "Bread Yeast Manufacture" (p. 311). The chapter on the manufacture of industrial alcohol introduces much matter of a purely academic character, but the text will be of little assistance to the general reader who wishes to gain an insight into the industrial processes. A useful feature of the book is the appendage to each chapter of references to the literature.

A. R. L.

Marine Works: a Practical Treatise for Maritime Engineers, Landowners and Public Authorities. By Ernest Latham. Second edition, considerably enlarged. Pp. xii + 223. (London: Crosby Lockwood and Son, 1926.) 16s. net.

THE second edition of this work consists of two parts, the first of which is identical with the earlier edition and the second is made up of three additional chapters. We have not been able to find any alteration in the first part, and it is accordingly open to the same criticisms as were expressed in the review which appeared in NATURE of Mar. 3, 1923 (p. 285).

As regards the additional matter, Chap. x. deals with quays and jetties in tidal waters and is obviously supplementary to Chap. ix. on deep-water quays. It consists of certain somewhat disconnected jottings on costs and valuations and modern practice in design. It contains, however, a timely and salutary admonition on the economical aspect of the selection of a site for the exploitation of a river frontage, and points out the advantages accruing from the use of runways and other modern transportation facilities. There is a note of a method advocated by the author for the determination of the actual volume of dredged material in computing payments to a dredging contractor. This point crops up again in the next chapter but one, where the same ground is covered, indicating a lack of care in avoiding repetition, which is almost inevitable when articles on the same, or kindred, subjects are reprinted *in toto* from journals.

The weakness of the book as a whole, in fact, is that it consists of a series of such articles, useful and interesting in their way, but discursive, disjointed, and, in some measure, superficial. Chap. xi. deals with coast erosion; here again the information contained would have been more appropriately blended with that in Chap. vi. on coast defence. The concluding chapter (xii.) discusses dredging and land reclamation. There is a useful appendix on "The Land Drainage Acts examined from the engineer's standpoint," reprinted from *Water and Water Engineering*. B. C.

General Botany: with Special Reference to its Economic Aspects. By Dr. C. Stuart Gager. With three Chapters on Heredity and Variation in Plants, by Dr. Orland E. White. Pp. xvi + 1056. (Philadelphia, Pa.: P. Blakiston's Son and Co., 1926.) 4 dollars net.

This is a text-book written along very different lines from the majority of books used as introductions to the study of botany. The work gives the impression that its author has not considered college and examination syllabuses, but has attempted to deal with botany as an indispensable subject of general education. It must be acknowledged that he has largely succeeded in showing that plant life has been throughout history, and still is, closely interwoven with human life.

A general introduction is followed by four parts, subdivided into forty-one chapters, dealing respectively with the vegetative functions of plants, reproduction and life-histories, the great groups of seed-bearing plants, and genetics and evolution. Features of special interest are: the excellent photographic reproductions, the insertion of short historical and biographical notes, and the discussion at every opportunity of the relationship of plants to human affairs. A few of the text figures are not quite accurate and several unfortunate slips in terminology have been noted. The majority of the bibliographical references are to American papers and books, and, naturally, most space is devoted to American genera and species. Nevertheless, this text-book is one that should be of great use to teachers and students not only in the United States but also outside.

The New Book of Trees. By Marcus Woodward. Illustrated with Wood Engravings by C. Dillon McGurk. Pp. 310. (London: A. M. Philpot, Ltd., n.d.) 12*s.* 6*d.* net.

The author of this work does not attempt to give elaborate scientific descriptions of trees, neither does he try to reveal anything that is new; rather, by delving into ancient tomes, he has brought to light much that is old but interesting. His researches are confined to the commoner kinds of trees and shrubs, and more particularly to native species. He has gathered together a good deal of historical information, and the chapter entitled "Remarks on Forest Scenery" is particularly interesting, dealing as it does with English woodlands from the time of the Roman invasion to modern times. In his descriptions of the variou species the author makes good use of the many legends and lyrics concerning trees and forests tha are to be found in old sylvicultural works.

Whilst the book is not one to recommend to the student of botany or sylviculture, it is well worth a place upon the shelves of other tree-lovers, whils people who have no special interest in trees will find much interesting reading. There are numerous good engravings by Mr. C. Dillon McGurk, and both printing and paper are good.

Hydrogen Ion Concentration of the Blood in Health and Disease. By Prof. J. Harold Austin and Prof. Glenn E. Cullen. (Medicine Monographs Vol. 8.) Pp. xi + 75. (Baltimore, Md.: Williams and Wilkins Co.; London: Baillière, Tindall and Cox, 1926.) 9*s.* net.

In this monograph the authors have set out to give a brief account of our present knowledge of the hydrogen ion concentration of the blood. In the first chapter there is a short but complete theoretica survey of the subject; whilst in the last, methods of determining *p*H are briefly described. The second chapter gives our knowledge of normal blood *p*H, and the third, which accounts for half the length of the book, describes the variations met with in disease. The authors have confined themselves strictly to the subject in hand, though, even then more than two hundred references are given in the bibliography. They also assume a fair knowledge of the subject from their readers: the clarity of certain portions of the monograph, especially those dealing with the more theoretical aspects of the subject, would be enhanced by somewhat fuller descriptions. The book should be of use to all those interested in the subject, as a work of reference to the latest researches.

The Chemistry of Dyeing. By Dr. J. K. Wood. (Chemical Monographs, No. 2.) New and revised edition. Pp. vii + 104. (London: Gurney and Jackson, 1926.) 3*s.* 6*d.* net.

This monograph, first issued in 1913, was written primarily for advanced students, but is of great interest to all who are engaged in processes involving dyeing. Commencing with a description of the physical and chemical properties of the more important commercial fibres, the book gives a short description of the principal types of dyestuffs and the methods of applying them to the various types of fibres. This is necessary in order to understand the following chapters, which deal with the numerous theories which have been advanced concerning the actual mechanism of the dyeing process. These theories are very lucidly explained with great attention to experimental evidence, starting from the first idea of a purely mechanical process to the modern conception of dyeing as a dual process, involving first the electrical precipitation of the dye on the fibre and then the chemical combination or physical solution in the cell walls. The references to the published literature are unusually copious.

Letters to the Editor.

The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*]

Simultaneous Ionisation and Excitation by Foreign Ions in a Gaseous Mixture.

WE have recently carried out some experiments which indicate that an ion of one kind may, upon collision with a molecule of another gas, ionise that molecule and excite the resulting ion to the degree that the energy required to ionise the one exceeds the energy required to ionise the other. This means that an ion may rob a molecule of an electron, and at the same time give to the resulting ion the excess of energy made available by its recombination with the electron over the amount needed to take that electron out of the molecule. As the energies of excitation are quantised, there is usually still a remnant of the energy of recombination yet to be accounted for, and this probably goes into increased kinetic energy of one or both particles involved in the collision.

The experiments have been limited to mixtures of carbon monoxide and of nitrogen with argon, neon, and helium, but the same process may occur in any mixture of gases and vapours, monatomic or multi-atomic. We used carbon monoxide in particular because the energy levels of the CO molecule and the CO^+ ion have recently been experimentally determined in this laboratory [1] and interpreted on the basis of the quantum theory of band spectra.[2] Spectrograms were taken with a Hilger E2 quartz spectrograph of low voltage arcs of 40 milliamperes at 23 volts in a hot cathode discharge tube through mixtures of argon, neon, and helium in turn, each containing ten per cent. of carbon monoxide. The total pressure of the mixture was 2·4 mm. in each case. An auxiliary filament was mounted near the cathode filament so that electrons could be introduced into the discharge from it when desired. The purpose of the auxiliary filament was to enable us to determine whether the carbon monoxide bands were being excited by the rare gas ions or by the electrons from the cathode, and whether the excitation was accomplished simultaneously with the ionisation or was a subsequent event.

The spectrograms show that, in the argon mixtures, none of the negative bands of carbon monoxide or of nitrogen is excited; in the carbon monoxide-neon mixtures the comet tail bands and the first negative bands of CO^+ appear, the former strongly and the latter weakly, but the Baldet-Johnson bands are absent; in the helium mixture all three negative systems of carbon monoxide are strongly developed. The negative bands of nitrogen appear fairly strong in the nitrogen-neon mixture and very strong in the mixture with helium.

Before it could be concluded that these negative bands were being excited simultaneously with the ionisation of the molecule on collision with an ion of neon or of helium, several alternative possibilities had to be tested:

1. The excitation of the ion might follow as a later event after the molecule had been ionised by the rare gas ion. That this process was not operative was demonstrated by introducing into the discharge, electrons from the auxiliary filament at a voltage sufficiently great to excite the CO^+ ions on collision. Although the electron current from this filament was twice as great as from the cathode, no increase in the intensities of the negative bands was produced. Thus, though the current through the discharge was three times as great as before, the negative bands were no more intense. On the other hand, the positive bands of carbon monoxide, which were not present in the original discharge, appeared with moderate strength in the discharge with the auxiliary filament in operation, when the difference of potential between the auxiliary filament and anode was equal to the excitation potentials of these bands. The second positive bands of nitrogen were present even though the auxiliary filament was not used, but their intensities increased enormously when the voltage of the auxiliary filament reached their excitation potential. This suggests a new method for determining the excitation potentials of positive bands and arc lines.

2. The simultaneous ionisation and excitation of the carbon monoxide molecule might be due to direct electron impacts, as has been demonstrated to be possible.[1] That this was not the case was proved by maintaining the voltage of the auxiliary filament higher than the excitation potentials of these bands but below the ionising potential of neon. In this way the possibility of excitation by electron impacts was increased threefold, while the concentration of neon ions was increased very little. A barely perceptible increase in the intensities of the negative bands was observed when the current from the auxiliary filament was twice as great as from the cathode.

3. The ionisation and excitation might be due to an impact of the second kind with an excited neon or helium atom. It was for the purpose of determining whether the ion or an excited atom of the rare gas was responsible for the observed phenomena that nitrogen was substituted for carbon monoxide in the neon mixture. The excitation potential of the negative band system of nitrogen is greater than either of the strong radiating potentials of neon, but is less than the ionising potential of neon. Therefore, an excited neon atom could not ionise the nitrogen molecule and simultaneously excite its negative bands. Hence we must conclude that it is the rare gas ions that were effective.

The interpretation of the observed results on the basis of simultaneous ionisation and excitation by the ions of the inert gases is fairly obvious upon consideration of the excitation potentials of the bands involved and the ionisation potentials of argon, neon, and helium as given in the following table:

Band System.	Excit Pot.	Gas	Ionis. Pot
Comet Tail . .	16·8	Argon	15·4
First Negative .	20·0	Neon	21·5
Baldet-Johnson .	22·9	Helium	24·5
		Carbon Monoxide	14·3

Thus none of the negative bands of carbon monoxide would be expected to appear in the argon mixture, while the comet tail bands and the first negative bands would be excited by neon ions, and all three systems by helium ions, as was observed.

Apparently the neon ions are more efficient in exciting the comet tail bands than they are in exciting the first negative bands. This greater probability that the former would be excited rather than the latter upon a collision between a neon ion and carbon monoxide molecule would seem to indicate that the efficiency of ions in this type of excitation increases, at least for a time, as the excess energy available increases. This view is supported by the fact that all three systems are strongly developed in the helium mixture. Several bands belonging to the comet tail and Baldet-Johnson systems not previously reported were observed in our spectrograms of the carbon monoxide-helium mixture.

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[1] Duffendack and Fox, *Science*, 64, p. 277, 1926, *Astrophys. Jour.*, in press.

[2] Birge, NATURE, 117, pp. 229, 300, 1926, *Phys. Rev.*, 28, p. 1157, 1926; Johnson, NATURE, 117, 376; 1926; Duffendack and Fox, NATURE, 118, 12; 1926

The failure of the Baldet-Johnson bands to appear in the neon mixture and their strong development in the helium mixture is significant. According to Birge,[3] these bands constitute a combination system between the initial states of the first negative and the comet tail systems. If this were true, they would have the same excitation potential as the first negative bands and should be excited by neon ions. Their experimentally determined excitation potential[1] is in agreement with their behaviour in the neon and helium mixtures. This confirms the assignment of this system to a higher initial state of the CO⁺ ion as made by Duffendack and Fox.[2] It might be added that Miss Ann Hepburn, at the Chicago meeting of the American Physical Society, corrected her published abstract[4] and reported the excitation potential of this system to be 23·0 volts, in agreement with the value given above.

The appearance of the negative band systems of carbon monoxide and of nitrogen in our discharges is in harmony with their appearance in geissler tube discharges through similar mixtures as observed by Merton and Johnson[5] and by Cameron.[6] Their presence can be accounted for on the basis outlined above, and slight discrepancies can be explained by the less definite limitation of the maximum speeds of the electrons in geissler discharges. Similar discrepancies can be produced in our discharges by increasing the voltage, or the current density, or the percentage of carbon monoxide, or in any way increasing the probability of excitation of the carbon monoxide molecules by direct electron impacts.

There is no reason to believe that this method of excitation of radiation from an ionised molecule is limited to the ions of the rare gases or to multi-atomic molecules. The same process may be expected to occur in any mixture of gases or vapours, and should find application in the production of the first spark spectra of atomic ions to the exclusion of higher spark spectra, and in the approximate determination of the excitation potentials of the spark lines. This process may also explain the enhancement of certain lines in discharges through mixtures of gases and the origin of certain radiations of astronomical interest.

We wish to express our gratitude to Dr. W. E. Forsythe, of the Nela Research Laboratory (where these experiments were begun during the summer of 1926) for the argon, and to the U.S. Bureau of Mines for the helium used in these experiments.

O. S. Duffendack.
H. L. Smith.

University of Michigan,
Ann Arbor, Mar. 15.

Spinning Electron and Wave Mechanics.

In order to obtain an interpretation of the anomalous Zeeman effect, the multiplet structure, etc., Uhlenbeck and Goudsmit (*Physika*, 1925; *Naturw.*, 953, 1925; Nature, 117, 264; cf. Thomas, Nature, 117, 514; Slater, Nature, 117, 587; London, *Naturw.*, 15, 15, 1927; Darwin, Nature, 119, 282) assume that the magnetic moment corresponding to the spinning movement of the electron is just twice as great as that of the revolving electric point-charge with the same mechanical angular momentum. In the following, an attempt is made to derive this assumption from the relativistic Schrödinger wave equation in connexion with the electrodynamic meaning of the wave function ψ.

The relativistic wave equation for forceless movement of the electron is:

$$\Delta\psi - \frac{1}{c^2}\frac{\partial^2\psi}{\partial t^2} - \frac{4\pi^2}{h^2}m_0^2c^2\psi = 0. \qquad (1)$$

(Schrodinger, *Ann. d. Ph.*, 81, 133, and other authors.) The solution, in the rest-system of the electron, may be reduced to the following form (r, z, ϕ being columnar co-ordinates, which are suitable to the purpose):

$$\left.\begin{aligned}\psi &= f(r,z)\ \text{exp.}\ is\phi\ \text{exp.}\ \frac{2\pi i}{h}m_0c^2t\\ &= F(r,z,\phi)\ \text{exp.}\ \frac{2\pi i}{h}m_0c^2t\end{aligned}\right\} . \qquad (2)$$

F satisfies the equation: $\Delta F = 0$, and is therefore harmonic in the rest-system.

The equation of the continuity of electricity is:

$$\text{div.}\left\{\frac{h}{2\pi i}(\psi\ \text{grad.}\ \bar\psi - \bar\psi\ \text{grad.}\ \psi)\right\} + \frac{\partial}{\partial t}\left\{-\frac{h}{2\pi i}\frac{1}{c^2}\left(\psi\frac{\partial\bar\psi}{\partial t} - \bar\psi\frac{\partial\psi}{\partial t}\right)\right\} = 0. \qquad (3)$$

(See W. Gordon, *Zs. f. Phys.*, 41, 117, see p. 121, and O. Klein, *ibid.* 41, 407, see p. 414.)

We multiply the expressions in brackets by the specific charge $\frac{e}{m_0}$ of the electron (the introduction of the factor $\frac{1}{2}$—as introduced by Klein—cannot be justified in our case) and get for the electric density:

$$\rho = \frac{e}{m_0}\left\{-\frac{h}{2\pi i}\frac{1}{c^2}\left(\psi\frac{\partial\bar\psi}{\partial t} - \bar\psi\frac{\partial\psi}{\partial t}\right)\right\}, \qquad (4a)$$

and for the density of current:

$$j = \frac{eh}{2\pi i m_0}(\psi\ \text{grad.}\ \bar\psi - \bar\psi\ \text{grad.}\ \psi). \qquad (4)$$

From the non-relativistic form of the wave equation only half the density of current follows (cf. Schrödinger, *l.c.*). From that Fermi (Nature, 118, 876) and Klein (*Zs. f. Phys.*, 41, 425) have derived the magnetic moment for the revolving movement of an electric point-charge, namely:

$$\mu' = -\frac{e}{m_0}\frac{h}{4\pi}s', \qquad (5')$$

whilst the magnetic moment corresponding to the density of current (4) is:

$$\mu = -\frac{2e}{m_0}\frac{h}{4\pi}s. \qquad (5)$$

μ may be regarded as the magnetic moment of the spinning movement, being twice as great as μ' in agreement with the assumption mentioned in the beginning. The conjectures of Slater and London that the rest-energy m_0c^2 is of rotatory character and that the 'internal phenomenon' of L. de Broglie of the frequency $\nu_0 = \frac{m_0c^2}{h}$ causes it and therefore the magnetism of the electron itself, are supported by this.

The necessary half quantum-numbers for s follow readily if one adapts the Schrodinger conditions for the wave function ψ to our problem.

Only the doublet $(\frac{1}{2}, -\frac{1}{2})$ and no higher quantum-states of rotation appear.

We hope, in an early communication, to return to the question of fine structure and analogous problems.

E. Guth.

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[3] Birge, Nature, 116, 207; 1925.
[4] Hepburn, *Phys. Rev.*, 29, 212; 1926.
[5] Merton and Johnson, *Roy. Soc. Proc.*, A, 103, 383; 1923, Johnson and Cameron, *ibid.* 106, 195; 1924; Johnson, *ibid.* 108, 343; 1925.
[6] Cameron, *Phil. Mag.*, 1, 405; 1926.

Occurrence of Branched Hairs in Cotton and upon *Gossypium Stocksii*.

IN the columns of NATURE of Mar. 12, p. 392, Mr. N. W. Barritt describes branched hairs in a specimen of Egyptian cotton. Such branched hairs of Gossypium have been known to us for some time and have been the subject of an investigation by us which we hope shortly to publish.

We have growing here each year in our experimental area what is probably the most representative collection of Asiatic types of cotton to be found anywhere in the world. Amongst several of these types, by the exercise of patience, we have found these branched hairs, as also in Upland American and Sea Island types. The branched hair represents a form of hair that occurred in the phylogeny of the Hibisceæ. It is very well seen in *Thespesia populnea*, upon the seed coat of which there are hairs of at least two types, one of which is branched and another unbranched. The branched type is shown in the photomicrograph (Fig. 1). The length of this hair is 0·9 mm.

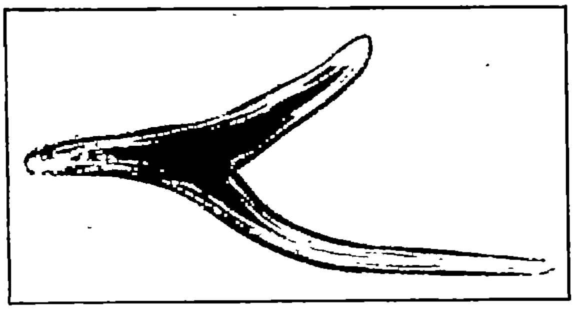
FIG. 1.—Branched hair of *Thespesia populnea*, 0·9 mm. long.

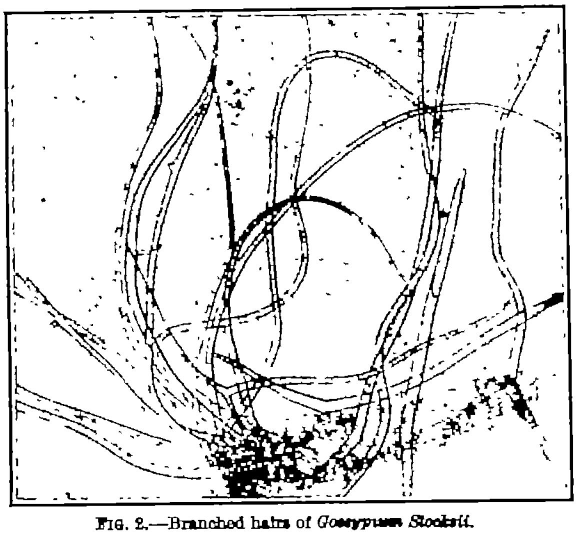
FIG. 2.—Branched hairs of *Gossypium Stocksii*.

In *Gossypium Stocksii*, a type of cotton in some respects primitive, hairs occur within the capsule not only upon the seed coat but also upon the capsule wall. Many of these hairs, both upon the seed coat and the capsule wall, show branching. These are shown in Fig. 2. Coming off from the mass of capsule wall shown in this photograph is a bifurcate hair with a very short basal part embedded in the wall. To the left of this is another similar one with a longer base than the former. Hairs with shorter side branches can be seen in several places. The hairs on the seed coat of *Gossypium Stocksii* are usually regarded as of the nature of 'fuzz.' In our material they are some 8 mm. to 10 mm. long.

It seems probable that in the modern forms of Gossypium the branched hair has become suppressed, and usually develops only tardily and to a limited extent in the form of 'fuzz.'

We have *Gossypium Stocksii* from the Sind Desert growing and flowering here now. There are several characters in it that have never been correctly described. In our material there are no signs of any stipular glands at the base of the clawed bracteoles as figured in Watt's "Wild and Cultivated Cotton-Plants of the World." The flowers of our material, too, could not be described as 'large'; in comparison with most other Asiatic cottons, they are small. In colour the flowers are pale sulphur yellow and of a totally different shade from that of Asiatic cottons generally. The pollen grains, in the character of their spines, differ from those of any other Asiatic Gossypium seen by us. An investigation has been made into the cytology of *Gossypium Stocksii*, and thirteen chromosome bodies have been found in the developing pollen grain.

W. YOUNGMAN.
S. S. PANDE.

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Intensities of Molecular Beams.

KNAUER and Stern (*Zs. f. Phys.*, 39, 775) have recently investigated the relation between the intensity of a beam of mercury molecules and the pressure in the oven or source chamber. They have found that the intensity of the beam increased uniformly with the oven pressure, until the mean free path in the oven was about equal to the width of the oven slit. At this pressure the beam had a maximum intensity, becoming less intense as the oven pressure was increased above this optimum value. As an explanation of this maximum, they have suggested that the molecules emerging from the slit, at pressures greater than the optimum pressure, collide with one another, giving rise to the formation of a cloud in front of the slit. Instead of originating in the slit itself, the beam then has its source in this diffuse surface of low intensity.

This explanation does not seem correct, when a consideration is made of the frequency of the collisions taking place between the molecules which have passed through the oven slit. An indication of the probability of such collisions may be gained from a calculation of the free path in an ideal gas the molecules of which are moving in a single direction with a Maxwellian velocity distribution. The result of such a calculation shows that the mutual collisions between the molecules within the beam are so infrequent as to produce no appreciable effect on the intensity of the beam, except at oven pressures far greater than the optimum pressure observed by Knauer and Stern. The diminishing intensity of their beam, as the pressure was raised above the optimum pressure, was more probably due to scattering by molecules which had been reflected from the uncooled walls of the chamber between the slits. The reason for this statement will appear from the following experiments.

A beam of mercury molecules was formed in a manner similar to that of Knauer and Stern, with the important difference that *the region between the two slits was entirely surrounded by a liquid air cooled surface.* In this way all molecules were removed from this space at their first impact with the walls, with the exception of a small fraction which were striking an uncooled surface near the image slit. The slits were each 0·1 mm. wide by 1 mm. long and were separated by a distance of 7 cm. The intensity of the beam was measured by means of an ionisation gauge, having as its only opening a slit of the same dimensions as of the two referred to above. The gauge was mounted in the vacuum in such a manner that it could be moved into or out of the beam at a point 8 cm. beyond the image slit. The change of pressure which took place in the ionisation gauge, when it was moved from a position outside of the beam into its centre, was assumed to be proportional to the intensity of the beam.

With this arrangement a beam could be detected when the oven pressure was 0·1 mm., a pressure slightly below that at which a maximum would be expected to occur, if the interpretation which Knauer and Stern have placed upon their results is correct. It was found, however, that with oven pressures ranging from 0·1 mm. up to 30 mm., *the beam intensity increased uniformly with the oven pressure.* Within this pressure range the beam was well defined and had the width calculated from the geometry of the slits. At oven pressures greater than 30 mm., the beam intensity increased more slowly with the pressure, and passed through a maximum at an oven pressure of 100 mm. Within this range the beam gradually became more diffuse, until at the last pressure it was several times its geometric width.

The maximum may be analogous to the maximum observed by Knauer and Stern; it is possibly due to scattering by molecules which have been reflected from the small uncooled area near the image slit. The more complete elimination of such reflected molecules accounts for the fact that the maximum occurred at an oven pressure about one thousand times greater than that predicted by Knauer and Stern.

The mutual collisions referred to above are also an important cause of scattering at these large beam intensities. For this reason the production of a beam of greater intensity will not be materially aided by a further elimination of the reflection of molecules from the walls of the chamber between the two slits.

Thomas H. Johnson.

Sloane Physical Laboratory,
Yale University, April 22.

The Mechanism of 'Knock' Suppression.

The letter by Messrs. Egerton and Gates in the issue of Mar. 19, p. 427, concerning the mechanism of 'knock' suppressors such as lead tetra-ethyl, prompts me to add certain points of view material to the discussion.

The idea that lead tetra-ethyl acts as an inhibitor of the oxidation of aldehydes was expressed by me in January 1924 at a meeting of the North-Eastern Section of the American Chemical Society in Boston, reported in the News Edition of *Industrial and Engineering Chemistry* for February 1924, and in *Chemical and Metallurgical Engineering*, vol. 30, p. 148 (1924). At that meeting I was able to show an experiment in which the rate of oxidation of 5 c.c. of benzaldehyde was decreased from 1·5 c.c. absorbed oxygen per minute to 0·005 c.c. per minute by the addition of one drop of lead tetra-ethyl to 5 c.c. of benzaldehyde. The report of this work has been delayed, but a forthcoming publication by Mr. H. J. L. Bäckstrom will record in detail work of which this is one phase.

In the meantime we have obtained other results which demonstrate one other possible mechanism of known suppression by lead tetra-ethyl. Charch, Mack, and Boord have suggested (*Ind. Eng. Chem.*, 18, 336; 1926) that the suppression is to be associated with the liberation of fine particles of the free metal in the gaseous mixture, these atoms functioning as catalysts of oxidation, themselves undergoing rapid oxidation and producing, at a definite stage in the engine cycle, a large number of oxidation centres. A homogeneous combustion throughout the gas mixture ahead of the flame front would thus occur, thereby suppressing the formation of a detonation wave and consequent knock.

Our own experiments on the properties of hydrogen atoms (*Trans. Faraday Soc.*, vol. 21, 1926) have led also to a study of the decomposition of metal alkyls of the lead tetra-ethyl type and to an important addition to the above concept. Not only may the lead atoms function as oxidation centres, but also, and to a very much more marked extent, the free radicals, *e.g.* C_2H_5, liberated by the thermal decomposition, are extremely reactive in the presence of hydrocarbon-oxygen mixtures. Complete disappearance of oxygen is secured at temperatures below 300° C. Indeed, with hydrogen atoms, in the presence of ethylene and oxygen, reaction is secured at room temperatures, oxygenated organic compounds being produced. Free radicals, therefore, may function as oxidation centres producing homogeneous combustion, an effect supplementary to the inhibitory action of the metal alkyl on oxidation of the aldehydes produced by partial oxidation of hydrocarbons. The action of the free radicals may well account for the inhibitory effects produced by non-metallic knock suppressors of the type of aniline. As yet, there does not seem to be any method whereby the relative importance of these several possibilities may be estimated.

Hugh S. Taylor.

Princeton University,
New Jersey.

A Mawken Canoe in Algoa Bay.

Accompanying this is a photograph (Fig. 1) of a dug-out canoe which I found washed up on the sea beach in Algoa Bay at a point known as New Brighton. The canoe is 22 feet long, 16 inches in width, and 14 inches deep. It has been hollowed out from a large tree. Towards the stem there is a cavity in the bottom of the canoe for the reception of a mast. The side pieces, which have the appearance of rowlocks, can be clearly seen in the photograph.

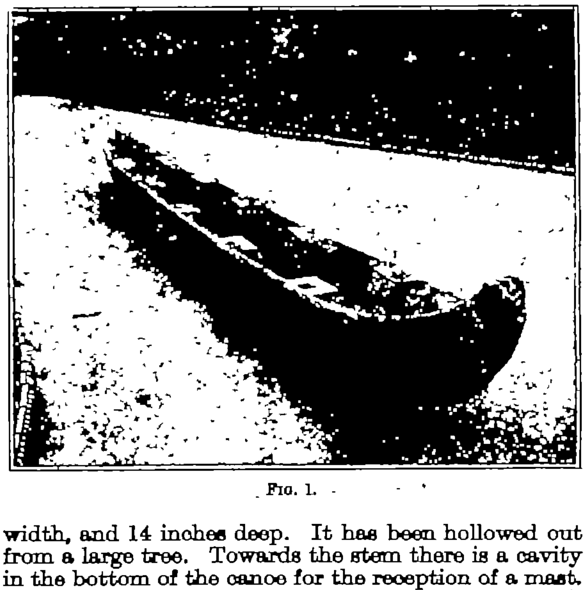

Fig. 1.

Dr. Ernest Schwarz, professor of geology at the

Rhodes University College at Grahamstown, made a careful examination of the canoe, and definitely stated it was not of African origin. He advanced the opinion, confirmed later, that it came from the Mergui Archipelago, which consists of a group of small forest-covered islands in the Bay of Bengal to the north of Sumatra. I have consulted the book entitled "The Sea Gypsies of Malaya," by Mr. Walter Grainge White, which seems to prove that Prof. Schwarz is right. The relic appears to be the hull or base on which a superstructure was built. The so-called row-locks are evidently for the purpose of receiving slats of wood to form ribs. Along these the sliced stems of palms are bound, and the joints caulked with a resinous gum obtained from the forest trees. On cross pieces of bamboo a deck of split bamboos is laid down, and also caulked. At one end (the stern) a small shelter with a mat cover is erected.

These boats are the floating homes of a primitive race of people known as the Mawken.

Presuming our canoe is of Mawken origin, how came it here, a distance of some 5000 miles from its original home? Was it carried by means of the Malabar ocean current which has its origin in the Bay of Bengal? It is, however, the only relic of its kind which has been recorded from South Africa. F. W. FitzSimons.
(Director.)

Port Elizabeth Museum,
South Africa.

A Mutant in Cotton.

On the Government Farm at Dharwar, Bombay Presidency, India, I have for several years had under observation pure lines of cottons of several species and varieties. One of these was *Wagale*, a Burmese variety of *Gossypium neglectum* Tod. From 1919 this variety has been self-fertilised, and only the self-fertilised seed used for sowing in each generation, of which there has been one per annum. Like all the Indian cottons, this variety has normally had simple and stellate hairs on stem, petiole, and leaf. The variety bred true for this character of hairiness until 1925, in which season there appeared one plant which was entirely glabrous.

The normal plant has a ginning percentage of about 30, but the hairless plant had no lint at all although its seeds showed the shorter 'fuzz.' The petal length was also shorter than normal, averaging 17 mm. as against the normal 35 mm. This plant was self-fertilised and seeds were produced. In the season of 1926–27 these seeds were sown, giving 80 plants, all showing absolute hairlessness, lack of lint, and short petals. This new type appears to be a genuine mutant. Its behaviour in further generations and in crosses is being studied. G. L. Kottur.
(Cotton Breeder.)

Bombay Agricultural Department,
Dharwar, India, Feb. 19.

The Microscopical Examination of Flint Surfaces.

I am glad to see my friend Mr. Reid Moir is turning his attention to the surface-structures of fractured and fissured flints (Nature, April 16, p. 560); and I am sure we shall know something more about them before he has done with them. For more than fifty years I have been pointing out some of these, and the differences in their subsequent disposition to metamorphoses. I used to liken them sometimes to bread cut and broken, both in appearance and in their action when we turn them into the soup. The transitional Fawkhamian implements are splendid examples of these: every man-fractured (or flaked) face is now porcellanised, while the 'natural' facets have been altering ever since.

The question, however, is not quite so simple as it might appear. There are eight factors that enter into the formation of the macro- and micro-surface-structures of free struck (fractured) and thermal fissured flints; these are: (1) the state and its variety to which the particular flint belongs; (2) the exact point the specimen has reached in the collo-crystallar evolution; (3) the degree and kind of metamorphoses the flint has attained; (4) the degree of molecular rearrangement associated with disruption it has reached and which of the various forms of these are present; (5) the support at the moment of fracture (resilient or rigid); (6) the shape of the striking-face; (7) the shape and nature of the striker (hammer); (8) the velocity of the blow.

In addition to these, in the case of thermal fissure, much will, of course, depend upon whether the heat be oxidising or reducing. W. J. Lewis Abbott.

Fluorescence of Sea Anemones.

I noticed recently, upon the rocks in Torbay, a number of sea anemones the tentacles of which appeared to fluoresce in sunlight. The effect is limited to the tentacles, for they appear to have a pinkish-brown colour by transmitted light, which changes to vivid green when viewed by light reflected from their surface. The body of the anemone itself is yellowish-brown and does not appear to fluoresce: nor do the pink tips of the tentacles.

Wishing to confirm the effect, I brought two specimens to London, and on placing them in a beam of ultra-violet light from which the visible radiation was filtered, the brilliance of the green fluorescence was very striking. I would suggest, therefore, that a source of ultra-violet light might be a useful adjunct to marine biological laboratories.

Charles E. S. Phillips.

Castle House,
Shooter's Hill, S.E.18.

The Modern 'Zoo.'

On behalf of the Council of the Zoological Society of Scotland I should like to express to you our great appreciation of the excellent notice in Nature of the Society's appeal for funds for the continued development of the Zoological Park here. The publicity given, through Nature, to our aspirations and our necessities will aid very greatly the effort we are now making, and I thank you most cordially for it.

Perhaps you will permit me to add that if any of your readers would be interested to receive a copy of the illustrated appeal, which contains a fairly full description of the Park, I should be very pleased to send one to any address given me, and if any one should be generous enough to subscribe towards our development fund, I shall be most happy to receive and acknowledge subscriptions.

T. H. Gillespie.
(Director-Secretary.)

The Zoological Society of Scotland,
Murrayfield, Edinburgh, W.

The Law of Flame Speeds.

The quotation by Mr. A. G. White in Nature of May 7, p. 674, is misleading from the context, and we would refer readers to the preceding paragraph in the paper from which the quotation is made (*Jour. Chem. Soc.*, 1919, 115, 1455. W. Payman.
R. V. Wheeler.

Safety in Mines Research Board,
Sheffield, May 12.

Logic and Law in Biology.[1]

By Dr. P. Chalmers Mitchell, C.B.E., F.R.S.

TEN years after the publication of the "Origin of Species," Kelvin, then Sir William Thomson, threw a bomb into the camp of the apparently victorious evolutionists. "It was quite certain," he said, "that a great mistake had been made—that British popular geology at the present time was in direct opposition to the principles of Natural Philosophy." According to the great physicist, the rate of cooling of the earth and other physical 'principles' showed that our globe could not have been in a position to support life for longer than a period of from 50 to 300 million years. In his opinion, the drafts on the bank of time demanded by those who upheld uniformitarian geology and the evolution of plants and animals could not be honoured.

Science rebuking science! It was meat and drink to the disheartened supernaturalists, the more reviving because in these days physical science was in good odour, and the new doctrine of evolution was the enemy. Huxley dealt with it in his presidential address to the Geological Society in 1869. He had no difficulty in showing that Kelvin's 'principles' were not unbending laws with universal jurisdiction, but merely combinations of observation, inference, and theory in different proportions. He took his final stand on the simple ground that as there was sufficient evidence for the orderly succession of the rocks and the orderly appearance of fossils in them, there must have been sufficient time for these processes. From this logical viewpoint he reached a remarkable result. Assume the correctness of Kelvin's calculation of the earth's rate of cooling and that yet there is sufficient evidence for evolution having taken place; why then there must be some unknown source of heat in the crust of the earth? Such a source of heat has been discovered in the radio-active elements, and from the rate of their disintegration the age of the oldest sedimentary rocks has been calculated at 1200 millions of years—a credit at the bank of time ample to meet all cheques presented by the followers of Lyell and Darwin. Twenty years later, in the course of an amusing controversy with the Duke of Argyll and a brace of bishops who had been talking about the suspension of 'lower laws' by 'higher laws,' as when a man raised a stone in his arm, he discussed the meaning of the term 'law' in science. He insisted that it was no more than the product of a mental operation upon the facts of Nature which had come under observation. It had no external existence and included no conception of causality. He took as examples the Newtonian laws of gravity and of motion and the law of constancy of mass.

At the time, Newton's laws must have seemed as securely established for the whole universe as any principle of science, and the constancy of mass through all chemical changes appeared to be a foundation of chemistry. With regard to both, Huxley insisted that they had no necessary sway. He stated the laws as to gravitation in such terms that they require not a word of alteration now that Einstein's unexpected discoveries have been made and confirmed. With regard to the constancy of mass he went even further, and said that there was no reason in our knowledge of the facts why mass should not be found to alter with the conditions. Recent physics have shown that in the atomic system the mass of the electron is a function of its rate of motion.

If, as Sir Oliver Lodge believes, the disincarnated spirit of Huxley is still in conscious existence, there must be a wry grin on what corresponds with the face of a disincarnated spirit, if Huxley imagines that I am going to claim prophetic powers for him on the grounds that he anticipated the discovery of radio-activity, made allowances for Einstein's amendments of Newton, and foresaw the gyrations of the electron. Huxley laid no claim to any faculties not within the scope and the duty of every man of science. His mental discipline comprised accurate observation, clear statement, the most rigid scrutiny of generalisations, the withholding from these generalisations of any iota of causal principle or any right to application to sets of facts different from those upon which they were based, and, above all, the declaration of ignorance in preference to the invention of imaginary principles. If, as he believed, the writ of science is to run howsoever it may be in opposition to customs, traditions, beliefs, or dogmas, there is the more need for scientific men to distinguish carefully in their pronouncements, especially to the public, between generalisations well founded on observation, probables, possibles, and hopes.

The presidential address to the British Association at Liverpool in 1870 is a conspicuous example of Huxley's methods. He described simple facts of everyday life, such as the appearance of maggots in carcases, of moulds on fruit, of vinegar eels, and so forth, explained by the ancients as due to spontaneous generation of the living companions of corruption from the corrupting but dead matter. In 1668, Redi, the Italian, covered meat with gauze, watched the blowflies, attracted by the smell of putrefaction, settling on the gauze, but noted that as the eggs could not pass through the gauze no maggots appeared in the meat. From similar experiments Redi drew the generalisation that living organisms arose in nutrient media only when the living seeds of these organisms had previously gained access to the media. The gauze of Redi has now been replaced by the far more delicate methods of bacteriologists, and the generalisation has been extended to almost every kind of living thing with which we are acquainted. But the principle remains the same; such 'causation' as there may be lies in the meshes of the gauze or their equivalent, not in any absolute distinction between living things and inorganic matter. To this generalisation Huxley gave the name 'biogenesis'; to the opposite conception, that of the direct origin of living from dead or inorganic matter, he gave the name 'abiogenesis.' As if foreseeing how his statement might be abused, consciously or unconsciously, he went on to say in a memorable passage that, so far from seeing in biogenesis a necessary and absolute principle, it was his expectation—belief was too strong a word in the absence of evidence—that a spectator in far-distant geological times might have seen the actual origin of living matter from inorganic matter. His prevision was necessary. In a recent book, addressed to the wide public, Sir Oliver Lodge has said that the "doctrine of biogenesis is that life could alone produce life." In another recent book, addressed to a narrower circle, Prof. Lloyd Morgan, setting out from the article on biology in the 11th edition of the "Encyclopædia Britannica," says that the authors implied that "biological events are not susceptible of interpretation in terms of physics and chemistry." The authors said nothing of the kind. They wrote, "have not been interpreted." Advocacy of the supernatural in natural science seems to confer an obliquity of vision.

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[1] From the Huxley Memorial lecture delivered at the Imperial College of Science and Technology, South Kensington, on May 4.

My object is now to pass in rapid review some of the history of biology before Huxley and since Huxley, and to show how with a monotonous reiteration the craving for final causes has led many great biologists to extend their generalisations beyond their scope and to impose on them imaginary principles; in short, to invent gods and to place them in the machine to account for the part of the working not yet understood.

What is the order of events in the development of a new individual? Two eggs, similar in size and appearance, placed in an aquarium tank under the same conditions, grow, the one say into a mollusc and the other into a fish. In the words of Bateson, whose premature death removed from us one of the most active and productive workers in the long history of our science, "Shakespeare once existed as a speck of protoplasm not so big as a small pin's head. To this nothing was added that would not equally well have served to build up a baboon or a rat." I do not accept these crude statements without qualifications so great as to reduce them almost to nonsense, but they serve well to pose the main problem of biology, the likeness of offspring to parent. To biologists of the seventeenth and eighteenth centuries the answer was easy. Recall their pictures of the egg with the miniature of a human being coiled up within it. They believed that the process of development was the evolution or unrolling of a preformed minute adult, invisible to us only because of the imperfection of our optical appliances and the opacity of the medium. The English Harvey and some others were uneasy about this interpretation, but it was not displaced until Caspar Wolff in 1759 published the results of his observations on the development of the chick. Wolff was able to show that the germ was unformed material and that it assumed only gradually, stage by stage, the likeness of its parent.

Development is an epigenesis, the putting on of phase after phase. Wolff saw that the preformation theory was miraculous, differing, as he put it, only from ordinary miracles inasmuch as it had been performed once for all by the Creator at the beginning of the world. But having got rid of miracle in one way he introduced it in another. For he endowed his plastic organic material with a *vis essentialis*, an inherent force by which it wrought its own miracle. Wolff thus by actual observation freed biology from the chains of a preconception and set embryology on lines which have led to great advances in knowledge. But the theory he imposed on his observations has been the parent of a great brood, a whole Valhalla of false gods; hear the names of some of them: vital force, *nisus formativus*, bathmism, entelechе, creative evolution, emergent evolution, purposive striving—not one of them more than a beguiling word for ignorance.

After nearly two centuries rich in new knowledge of the observed facts of embryology, but with no important advance in theory, there came August Weismann. A skilled embryologist, he knew the successive phases of development to be a visible epigenesis and to recall at least in a general fashion the ancestral history. The fertilised egg-cell of a human being recalled the morphological grade of the protozoa, next assumed (as Huxley was the first to recognise) the appearance of the cœlenterate or two-layered creatures, then became a simple cœlomate, then a generalised chordate which might be about to become fish, flesh, or fowl, then an anthropoid stage man or ape, and only at a very late prenatal stage assumed definitely its human structure.

But Weismann found an exception to this orderly epigenetic progression. The cells which were going to become the gonad of the future adult did not wait to appear in their turn in their due order and place. They were separated, usually, if not invariably, at an extremely early stage, and preserving their individuality, were passed along through the developing embryo, occupying now one position, now another, until they reached their final place. The likeness between parent and offspring was thus shown to have a material basis and the link between ontogeny was given a local habitation and also a name, the germplasm. The daughter was only a delayed sister of her mother. Neglecting the complications due to parental crossing, the mother and daughter were products of the same germplasm.

With regard to the development of the individual, however, Weismann's endowment of the germplasm with a historic architecture was a return to a more subtle kind of preformation. The bricks of his imagined edifice were 'determinants,' separate particles so arranged as to be given off at precisely the time when they were required to control the development of the tissues into which they were marshalled. The initial stock of germplasm was thus disintegrated into sets of determinants with limited powers of control until each portion reached its final stage of being able to determine only one kind of cell or tissue. The plasm in these various stages of irreversible disintegration was what he called the somatoplasm. His interpretation brought into clear light the relative if not the absolute stability of the germplasm, found and stressed the material link between ontogeny and phylogeny. But his historic architecture and his determinants were imagined principles to give causal explanations of processes which were not yet understood.

Oscar Hertwig, a very able experimental embryologist, very soon showed that the stresses of the environment acting on adult and embryonic stages could overpower the control assigned to the historic architecture and compel reluctant material into forms which it would not otherwise have assumed. The irreversible disintegration of the germplasm could not account for the facts, and the accessory theories produced by Weismann and his followers were more ingenious than convincing. Hertwig's insistence on the moulding forces of the environment brought the fresh air of observation of facts into the study of embryology and opened up a new and fertile chapter. But he, too, had to invent a causal principle; the name of the god he placed in the machine was the control of the whole organism over its parts in such a fashion that they served the needs of the whole. It is a disconcerting circumstance that his deity is more powerful in the embryo than in the adult, and in the lower than in the higher organisms.

Making the large allowances necessary for the play of the environment in producing the characters of an organism, there remains much which must be assigned to the hereditary material. The Mendelian analysis of heredity and the physiological doctrine of hormones have found a material interpretation for some of the unexplained occurrences for which Weismann invented his historic architecture and Hertwig his 'control of the whole.' The brilliant experimental analysis of the Mendelians has shown that at least with regard to a certain number of characters, heredity is particulate, consisting of unit characters which may be combined in groups in various ways. There is, in short, a mechanism in heredity which is being explored, and converging advances in knowledge of the nuclear changes are finding a material seat for it. On the other hand, the rejection of the influence of the environment is leading Mendelians into fantastic extravagance. The pronouncement by Bateson, in his address as president of the British Association in Melbourne in 1914, was a return to a conception of preformation more miraculous than those of pre-scientific philosophers. Arguing from the success of Mendelian breeders in eliminating factors and their failure in their efforts to add factors, he suggested a similar limitation for Nature, and that the whole course of divergent evolution from the beginnin of life to the appearance of Shakespeare had com about by the elimination of factors.

The discovery by Brown-Séquard and D'Arsonva of secretions discharged into the blood stream b glands in addition to the secretions liberate through their ducts, and their extension of thi to the supposition that all organs and tissue might produce internal secretions, have bee carried much further by more recent work. I has been shown that many of these secretions called hormones, or chemical messengers, by Bayliss Starling, and W. B. Hardy, do exist and exercis highly specialised co-ordinating functions. The form a chemical nexus independent of nerv reflexes, and so far definitely reduce the unknow field for which Hertwig invented his mysteriou power of control by the whole over the part Experiments particularly on the development o batrachian larvæ have shown that secretion produced at one stage of the development contro the later stages. It may be that in hormones wil be found to be the material agents by which th germplasm controls the development of the individual. But those which have been studied s far are extremely precise in their action, and have been unable to find a trace of direct evidenc for the belief so greedily imbibed by those wh accept the evidence of the inheritance of acquire characters—the belief, for example, that if th plumage of a bird or the coloration of a mot becomes darker from the effect of some agent i the environment, the melanistic tissues will produc a changed hormone of such a kind that it wil influence the germplasm to produce melanisti forms.

To what general issue have I led myself in this rapid review of some biological problems in the light of Huxley's canons? Definitely to the position that if we scrutinise our generalisations and do not extend them to a class of facts from which they were not derived, if we do not endow abstractions with an independent reality, we shall find no logical ground to infer the existence of any but physical events in the world of living things. I agree that the phenomena of living things have not yet been fully interpreted in terms of the inorganic. But I note that every positive addition to biological knowledge in the last century, from the identification of Mendelian factors in heredity, the artificial fertilisation of ova and the other achievements of bio-chemistry, to Sir Charles Sherrington's exploration of mammalian reflexes, has been a diminution of the residuum to which it is possible to apply vitalistic conceptions. On the other hand, Philosophy, since she was judicially separated from science, has made no positive addition to knowledge. How far our progress will go, I do not know. It may only be a phase of anthropomorphism to expect that man can ever comprehend the universe. But science must pursue the quest, and if we adhere to what is called materialism in the simplest sense of the word, we shall at least in the future, as in the past, make positive additions to knowledge.

Some Properties of Coke.[1]

By Prof. J. W. Cobb.

Coke is formed when coal, heated out of contact with open air, softens and is blown into a porous mass by its own gaseous products of decomposition. The structure of the coke is determined by a number of circumstances, but the relation between the softening and the evolution of gaseous products of decomposition is all-important.

In the structure of charcoal the original structure of the wood carbonised is, to a considerable extent, retained in the resulting charcoal. The annual rings, marked by a difference in size in the cells, are to be seen quite plainly. In a coke made from a bituminous coal, the original solid structure has disappeared, and has been replaced by a porous honeycombed mass.

It is not every coal which undergoes coking. Anthracite, for example, does not soften or coke. The coking property has been associated chemically with the existence in the coal of substances which can be extracted from it by suitable treatment with solvents, but the interpretation of the results is controversial.

If the various factors are considered, it is not strange to find that the characteristics of a coke made from the same coal under different conditions are themselves very different. This consideration has even greater weight if one visualises the further complication of coke formation as it exists on the large scale, say, in a continuous vertical gas retort. The upper part of such a retort may be quite cool, gases escaping at, say, a temperature of about 100° C. Such an apparatus necessarily acts, to some extent, as a reflux condenser; some of the tarry products of decomposition from the lower and hotter parts of the retort will be recondensed around the cooler particles near the top, so that the descending coal charge is moistened by this film of condensate. If the film evaporates without decomposition a little lower in the retort, it will have produced a caking effect while it was wet and sticky but will have no ultimate coking effect. If it decomposes leaving a cementing residue, the coke will be the stronger for it. At high temperatures such a cementing action can also be exercised by the decomposition of such a gas as methane. Similar considerations apply to the coke oven.

It is for reasons such as these that the type of large scale apparatus used in carbonisation, its method of use, and the preparation of the coal as affecting the penetration of heat to the charge, and the facility of escape of products of carbonisation, become of nearly the same importance as the original character of the coal in determining the character of the coke made from it.

Water-gas.

One of the most important properties of coke industrially is its interaction with steam, producing water-gas—a mixture of carbon monoxide, hydrogen, carbon dioxide, with some undecomposed steam. This is made not only in the water-gas process proper, where coke is blown alternately with a current of air and with steam, but also in the gasification of coal in a gas producer which is blown with a mixture of air and steam, and again to some extent in the making of town gas, when some steam is blown into the bottom of the retort—the so-called steaming process.

Ash Constituents.

It was suggested by Haber many years ago in his "Technical Gas Reactions" (1903) that a constituent of the ash of the coke used in the water-gas process might stimulate reaction. We have gone further into this matter, being led to do so partly from a desire to obtain specific and quantitative information on that subject, and partly because we were specially interested in the behaviour of the nitrogen and sulphur compounds in coke where the ash constituents were known in some cases to exercise an important influence. For this purpose we prepared special cokes at 500° and 800° C. from coal with which had been incorporated 5 per cent. of such oxides as silica, alumina, lime, and ferric oxide, or equivalent quantities of other compounds, such as sodium carbonate. Since the original coal had been carefully chosen as containing only 1 per cent. ash, it would be reasonably hoped in this way to obtain an idea of the influence of each of the common ash constituents of coal in turn.

That the ash constituents were going to exercise some influence was obvious from the first trials of these mixtures made in an ordinary crucible test. The original coal when so heated gave coke buttons swollen and honeycombed. The iron oxide and sodium carbonate cokes were close-grained and uniformly porous, while the sodium hydrate mixture gave a barely coherent powder. Dr. Lessing, who had worked previously on the influence of catalysts on the carbonisation of coal, had claimed an influence on the character and yield of coke from this cause.

When we came to examine cokes prepared at 500° and 800° C., the results were suggestive. Considering the cokes prepared at 500° C., the presence of iron oxide and sodium carbonate altered the proportion of residual volatile matter. These cokes also differed in structure from the pure coke, being of a much closer and more evenly porous texture. This result would suggest that, whatever the ultimate explanation may be, the action of oxide of iron is to delay or modify the decomposition below 500° C., lessening the evolution of volatile matter from the softened coal and the consequent puffing-up of the mass. At a later stage, below 800° C. apparently, this volatile matter was evolved, but it was presumably then without effect on the structure because solidification had by that time occurred.

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[1] Substance of two lectures delivered at the Royal Institution on Mar. 29 and April 5.

Special Cokes in Steam.

We passed on to an examination of the comparative behaviour of these cokes when treated with steam at 1000° C. Marked differences between the cokes now appeared. The lime coke was plainly much more reactive than the pure coke, the iron oxide coke more reactive again, while the rate of steaming with sodium carbonate coke had to be pushed very high before there was any appreciable falling away from complete decomposition. Moreover, the composition of the gas attained was different. At a rate of 10 litres an hour, taking extremes, with the pure coke 61 per cent. of the steam was decomposed, and the water-gas contained 9·2 per cent. carbon dioxide, while the sodium carbonate coke had decomposed 98 per cent. of the steam, giving a water-gas containing only 0·4 per cent. carbon dioxide. It was interesting to speculate whether this difference in behaviour was a specific chemical effect due to the presence of these special constituents in the coke, or whether it was due mainly to the difference in physical structure which we knew had been brought about in the cokes during the preliminary process of carbonisation.

The tendency of opinion for some time has been to attach primary importance to the physical structure of coke as influencing its reactivity, and there seems to be no doubt that it is an important factor. It has, however, been demonstrated by impregnating the 'pure' coke with sodium carbonate (soaking in a solution and drying), that practically the same enhanced reactivity can be brought about in that way as by mixing with sodium carbonate before carbonisation, which eliminates the altered physical structure as playing the principal part in the enhancement of reactivity in this case. The results at lower temperatures were equally striking, a very noticeable feature being the low carbon dioxide content of the gas made by steaming sodium carbonate coke at 800° C.

Reactivity in Carbon Dioxide and Air.

Reactivity to carbon dioxide is probably most important of all and was next examined. The formation of carbon monoxide from carbon dioxide is at the root of the manufacture of producer gas by blowing air through a deep column of coal or coke, is all-important to the working of the blast furnace, and plays its part in every coal or coke fire.

Lower temperatures were used than with steam, because of the higher reactivities. 1 per cent. of oxide of iron was found to give more than half the enhanced effect which came from 5 per cent. An impregnated sodium carbonate coke was proved to be almost as active as one prepared by adding the sodium carbonate before carbonisation. With some of the special cokes, and more particularly the sodium carbonate coke, there was a falling off in reactivity as an experiment proceeded. An interesting observation made on the oxide of iron coke, which is likely to be of theoretical importance, suggests that reduced iron may be present and taking part in the cycle of reactions.

It is difficult to test for differences between cokes as to their reactivity with air at temperatures above the ignition point. This is largely owing to the experiment getting out of hand on account of rise in temperature when air or oxygen is used. We have made some attempts by limiting the heating effect in two ways, by using air diluted with nitrogen until it only contained 2 per cent. to 3 per cent. oxygen, and by leading it over a small flat surface of coke with a limited surface of 1 cm. square. Measurement showed that by this method it was possible to obtain combustion without accumulation of heat or rise in temperature.

In these experiments the behaviour of all the cokes was practically the same above 700° C., but at lower temperatures—400° to 600° C.—wide differences appeared. The opinion previously put forward is thus confirmed that at high temperatures the reactivity of cokes in general is so high in air that differences in behaviour depend upon the rate of supply of air to the coke particles rather than on the reactivity of the cokes. One remarkable feature noticed in these experiments was the apparent slowness with which the highly reactive sodium carbonate coke began to react with oxygen. The same phenomenon had been noticed in experiments on the temperature of ignition of the special cokes.

Heating of Coke in Air.

When air is passed through hot cokes differing in their degree of reactivity, the result obtained appears, at first sight, somewhat anomalous. In each case there is an effect due to the burning of coke to carbon dioxide on first contact, and while the air is in excess. Heat is generated, and if the air supply is the same for each of two cokes, the same heat will be generated by this primary reaction in each case. There follows, however, the further interaction between carbon dioxide and carbon, reducing some of the carbon dioxide to carbon monoxide, and the degree to which this action is carried on is greater the more reactive the coke. It is with respect to this second reaction that cokes differ so much.

Now one characteristic of the conversion of carbon dioxide to carbon monoxide by carbon is that it absorbs heat. The net result is that the difference between the two cokes shows itself in the difference of the cooling effect, and it is with the more reactive coke that the cooling effect is more pronounced. Hence, in blowing air into hot cokes, it is the less reactive coke which generates heat most quickly in the mass.

A comparison of this property has been effected on the laboratory scale. 10 gm. of coke was placed in a vertical, electrically heated furnace. A thermocouple was inserted from the bottom end of the furnace tube in such a way that the junction was 2 cm. distant from the upper surface of the coke. The furnace was then heated up to 700° C. and maintained at that temperature for one hour, after which the heating current passing through he furnace was left unchanged throughout the remainder of the experiment, and air was passed down the coke column at the rate of 50 litres an hour. The results obtained for three cokes named in the order of their reactivity to carbon dioxide—sodium carbonate coke, 'pure' coke, and beehive ven coke—indicate that the highest temperature effect in the interior of the mass has been attained with the least reactive coke for the reason explained, doubtless an important point in high-temperature smelting by coke.

INDUSTRIAL AND DOMESTIC APPLICATIONS.

I should like now to say a few words on the influence of some properties of coke (particularly eactivity) when used for various purposes. The implest case is perhaps that of the gas producer, in which coal is gasified by blowing with air or a mixture of air and steam. There is a first conversion of carbon to carbon dioxide by air quite near the grate of the producer at the bottom, but fter that the gasification of the descending carbon s the result of the conversion of carbon dioxide to arbon monoxide by the reaction $C+CO_2=2CO$. The efficiency and rapid working of the producer depends upon this reaction, so that the coke which s more reactive to carbon dioxide is, other things being equal, the best for the process. This is a reproduction on the large scale of the laboratory experiment last described.

Another interesting example is the domestic fire, where so much depends on the relative ease of ignition and the rapid spreading of heat through he body of the fire. With a hard and unreactive coke it is difficult to carry the heat forward from piece to piece. If there is a little volatile matter left in the coke which comes away in flames, the heat transference is much more rapid. Or, if the coke for any reason is more reactive, the same advantages obtain. There are, however, limitations to the advantages obtainable in either of these ways. If the amount of volatile matter is too great, or if too much carbon monoxide is produced by excessive reactivity of the coke, there may be a twofold loss. In the first place, these gases may screen the solid coke from oxygen and so prevent that rise of temperature on the surface which is all important if a cheerful fire is to be obtained, or if the fire is to have a high radiant efficiency. The other detrimental effect is more important and depends upon the following phenomenon.

A bunsen flame burning in the open radiates only about 10 per cent. to 15 per cent. of its total heat of combustion, or rather more if the flame is luminous. If, however, the flame is used as in a modern gas-fire, to heat a solid radiating surface, the proportion radiated comes up to somewhere about 50 per cent. Consequently, in a coke fire, that portion of the combustion which is raising the temperature of the solid coke surface is being very much more efficiently utilised than in combustion of flames from the top of the fire burning in the open. Thus one may take it that if the amount of gas evolved is relatively small, so that it can burn in the fire, raising the temperature of the radiating surface of coke, it is very effective. But larger quantities of gas burning from the top of the fire are comparatively inefficient.

In experiments made at Leeds on the same fire, burning different solid fuels, this phenomenon was much in evidence on measuring the radiant efficiencies obtained from the fires. The experiments require extension, but I may say that the results were in accordance with the foregoing considerations, and agreed substantially with those of Dr. Margaret Fishenden of the Fuel Research Board, in that coke was found to give a higher radiant efficiency than coal. One striking result obtained, however, pointed to the necessity of not having present in the coal, ash of such a quantity and kind as to form a coherent coating during the burning, which thus formed a screen around the burning material and lowered its radiant efficiency.

Another very interesting point was the behaviour of a coke soaked in sodium carbonate solution, and therefore very reactive. It burned very freely, with visible flames a foot long. In appearance it was attractive. As a matter of fact, its radiant efficiency was not so high as that of the medium temperature coke, and that for the reason that I have explained. It reacted freely, generated carbon monoxide in quantity, the carbon monoxide burned with long flames at the top of the fire, and its radiant efficiency was correspondingly low—a defect due to the high reactivity of the coke.

Obituary.

PROF. A. A. LAWSON.

IT is little more than a month since the formal opening of the new Botanical Department in the University of Sydney was described in NATURE, with an illustration given of the building itself (April 2, p. 509). Before those who read it were able to formulate, much less to convey to Prof. Lawson their congratulations on this tangible mark of his successful tenure of his chair, he was in his grave, in the South Head Cemetery that looks out seawards over the entrance to Sydney Harbour. His death, following closely on a serious operation from the effects of which he never rallied, took place on Mar. 26 at Sydney.

Abercrombie Anstruther Lawson was born in Fife, and entered the University of Glasgow as a medical student. After passing through the course in elementary botany, where his artistic skill had already attracted attention, for reasons of health he went to California, and entered the University of Berkeley, coming under the influence of such teachers as Setchell and Osterhout. Graduating as Master of Science in 1898, he became instructor in botany, having already entered on a career of research. He also studied later in Chicago and at Bonn, with published results which led to his appointment as lecturer in his old University of Glasgow in 1907. Having held this position for five years, he was appointed to the chair of botany in Sydney, where he not only secured the erection of a new Institute, the opening of which took place on Nov. 6, 1926, but he also built up a school of botany, with a large and growing body of students, and a highly creditable list of published researches.

Lawson's own published work falls into three groups, relating respectively to cytology, to the gametophyte of Gymnosperms, and to that of the Psilotaceæ. The first memoir on the pollen mother-cells of Cobæa formed the thesis for his degree. Already that delicacy of pencil craft was revealed which marks all his later work. Few microscopists have combined more effectively than he did refined cytological method with artistic skill. This was the first of a series of memoirs relating chiefly to meiosis, which were continued until 1912. They are characterised rather by faithful record of detail than by the establishment of new points of view. Armed thus with exact laboratory experience, he carried through a long series of observations of the gametophyte and propagative processes in the gymnosperms. These will stand as a permanent record of patient research, by an observer of high technical skill. They opened while he was still instructor at Berkeley: they were continued during the period of office in Glasgow, and later in Australia, where they related chiefly to local genera, such as Microcachrys and Pherosphæra. The last of this series was a particularly fine memoir on Bowenia, published in 1926, with eight plates (*Trans. Roy. Soc. Edin.*, vol. 54). At the time of his death, a further memoir on Macrozamia was already well advanced. His illustrations from the earlier of his memoirs on the Gymnosperms have been very widely absorbed into Lotsy's "Stammes-Geschichte," vol. 3. No one can in the future treat the Gymnosperms generally without frequent reference to the wide observational work of Lawson.

Lawson left his mark also in a third line of inquiry: in 1917 two memoirs appeared on the gametophytes of Psilotum and Tmesipteris, so long awaiting discovery. It is true that the ground has since been covered in greater detail for the latter by Holloway, and in particular in the embryology: but that need not detract from the exact delineation and description given of their gametophytes. Lawson had also wide interest in the Algæ. He had collected with Setchell on the Aleutian Islands and on the coast of California. He made a special journey to collect them on the Jamaican coast, and he was well posted in the British marine Algæ. But he appears never to have published upon them.

While it must be conceded that Lawson's work has been detailed and analytical rather than constructive, we should bear in mind that he was still a comparatively young man, and that the last twelve years have been devoted to the establishment and consolidation of a school of botany in Sydney. As they stand, his numerous memoirs have added substantially to the sum of positive knowledge. They may not have formed new patterns in the web of the science, but they have filled many of its blanks, not only with artistic effect, but also with honest and trustworthy records. It will be a pleasure to his friends to remember that the Royal Society of Edinburgh recognised the merit of his work, so largely published in its *Transactions*, by the award of the Makdougall-Brisbane Prize. A deeper satisfaction will be felt in the fact that the inclusion of his name in the recent list of selected candidates for fellowship of the Royal Society was published in time for him to have been aware of this high distinction and to receive the congratulations of his many friends in Australia, though his death has occurred before the date of formal election. F. O. B.

PROF. ADOLF MIETHE.

PHOTOGRAPHIC science has suffered a great loss in the death, on May 5, of Regierungsrat Dr. Adolf Miethe, professor at the Technische Hochschule in Berlin-Charlottenburg. Prof. Miethe was born in Potsdam on April 25, 1862, and studied physics, astronomy, and chemistry in Berlin and Göttingen. After working with Prof. Hartnack in Potsdam and then with Schulze and Bartels in Rathenow, he became director of Voigtländer und Sohn in Braunschweig, leaving this position in 1899 to become professor at Charlottenburg as successor to H. W. Vogel, the discoverer of the sensitising action of dyes on the photographic emulsion. According to the *Photographische Industrie*, Miethe was responsible for the teaching of scientific and practical photography in all its branches, photo-mechanical methods, spectral analysis, optics, and astronomy. He was also well versed in botany, mineralogy, and other subjects.

Miethe was the first to construct anastigmats, the name of which is due to him. He improved opera and field glasses, invented, with Gaedicke, magnesium flashlight photography, and introduced the isocyanine dyes as optical sensitisers for the photographic emulsion. It was due to his efforts that great advances were made in the three-colour collotype process. During the last year or two Miethe's name has been brought more prominently into general notice by his claim to have transformed mercury into gold, a claim which, however, has not been satisfactorily substantiated.

Miethe was prolific as a writer and was very successful in presenting scientific knowledge in such a form that it was readily understood by the general reader. Several books dealing with photographic subjects came from his pen.

WE regret to announce the following deaths:

Mr. J. Barnard, formerly senior mathematical master at Christ's Hospital, both in London and after its removal to Horsham, aged seventy-six years.

Sir Sidney Colvin, formerly Slade professor and director of the Fitzwilliam Museum, Cambridge, and keeper of prints and drawings at the British Museum, on May 11, aged eighty-one years.

Dr. Maurice F. FitzGerald, emeritus professor of civil engineering in Queen's College, Belfast, on May 4, aged seventy-six years.

Prof. J. S. Nicholson, until recently professor of political economy in the University of Edinburgh, on May 11, aged seventy-six years.

News and Views.

The first Conference representative of the Governments of the British Colonial Empire was opened in London by Mr. Amery, Secretary of State for the Colonies, on May 11. The speech in which Mr. Amery welcomed the delegates followed closely the lines of his address to the members of the Imperial Conference held last year. He dealt with the extent, resources, and trade of British undeveloped tropical and subtropical estates, and the diversity of problems, constitutional, economic, and cultural, and of the interest of every part of the Empire—including the self-governing Dominions—in the solution of those problems. There is, however, as he pointed out, very little structural or administrative unity to correspond with the unity of the problems and of the spirit in which they are approached. While the lack of co-ordination between the various parts of the Colonial Empire, their almost complete autonomy and self-sufficiency as regards their essential services is not altogether disadvantageous, yet it militates against the efficiency of those aspects of administration into which scientific method and scientific research enter, problems of agriculture, of veterinary science, of health, and of transport. In all these matters much closer co-operation and more effective interchange of information and ideas is needed, particularly of the trained and skilled personnel, who are the most effective agencies for the distribution and dissemination of such information and ideas. But, except for scientific research, Mr. Amery does not envisage a reconstruction of the services into large, all-embracing federal schemes, as he believes the end in view can be attained by the development of a system of consultation by conference.

While not suggesting any marked departure from existing practice in connexion with the technical services, Mr. Amery advanced the view that the prosecution of scientific research is of such vital importance to the whole Empire that it can no longer be left to local governments to determine. The scientific worker must be given a career, a career in which the field of work is just as important as monetary reward; and it so happens that the Colonies which offer the greatest opportunities for research, the development of which is most dependent on the results of research, are the ones which can least afford to offer the salary or the career which will attract the best men. Moreover, it may be that the problems of research of importance to a particular Colony could be best solved in universities or higher research institutions; or the results obtained in one Colony may have almost universal application. Some of the Crown Colonies are now sufficiently aware of this fact to have made the suggestion that a Colonial Scientific Service should be created, a proposition which it is interesting to note was made twenty-five years ago by the Federated Malay States. If the official representatives of the various colonial governments are prepared to agree with the principle of a unified scientific service, at any rate in the higher research grades of scientific and technical work, they should be able, before they separate, to agree also on the means by which such a service could be made effective. The trouble is, however, that very few of the representatives at the Colonial Conference have much idea of what is meant by scientific research. They either expect far too much in return for expenditure on research or they are contemptuous of the whole subject.

The new Electricity (Supply) Act has come into operation and the first scheme prepared by the Electricity Commissioners has been published (London: H.M. Stationery Office. 1*s.* net. Supplementary Particulars. 2*s.* 6*d.* net). It has been presented to the Central Board, and those interested will have opportunities of discussing it. The area selected covers most of the Scottish industrial area and includes Glasgow, Edinburgh, Dundee, and Dumbarton. Like most other engineering schemes it was necessary for the Commissioners to make estimates of the probable demand many years ahead, and we think that they have not been unduly sanguine. They have assumed that the output in Britain will double in about every eight years, and that at the end of 1941 about 450 units per head of the population will be consumed. This agrees fairly well with the 500 units given in the Weir report. Nearly 5000 square miles in central Scotland are covered by the scheme. Ten of the present generating stations have been selected as approved stations, but only six are definitely permanent. The ultimate fate of the other four depends on whether their directors are convinced that it is for their own good and the good of the main scheme that they should give up their status as selected stations. A heavy item in the cost is due to standardising the frequency of the alternating current supply. In the case of the Glasgow and Clyde Valley systems the gross cost of standardisation is estimated at about three and a half million pounds. If we are to get the full benefit of a national scheme, however, it is advisable to standardise at the earliest possible moment. The standard voltage for the 'grid' transmission network has been fixed at 132,000 volts, and the secondary transmission lines will operate at 33,000 volts. The power to be transmitted by a main line is not to be less than 50,000 kilowatts. Ring mains will be used, so that in the event of a breakdown at one point of supply the transmission at all the other points of supply is unaffected. The scheme seems to have been well thought out and should prove to be satisfactory.

The regretted death of Prof. A. A. Lawson, who was recommended for election into the Royal Society this year, left a vacancy in the number of new fellows, and this was filled by the election on May 12 of George Claridge Druce, M.A. (Oxon), D.Sc., Hon. LL.D. (St. Andrews), Fielding Curator in the University of Oxford. Dr. Druce is distinguished for his numerous contributions to systematic botany, and for his series of County floras (Oxfordshire, Berkshire, Northamptonshire, Zetlandia, West Ross-shire, &c.). He has discovered and described numerous plants, many of which bear his name. The Fielding Herbarium at Oxford owes much of its present importance to his devoted (and all but honorary) curatorship. He has rendered national service in stimulating and practically promoting the study of field botany among all classes of the community.

The two hundredth and twentieth anniversary of the birth of Carl Linnæus, the naturalist, occurs on May 23. Born in 1707 at Råshult, in Sweden, he died on Jan. 10, 1778. His father, the rector of the parish, sent his son in the first instance to the University of Lund; afterwards he entered the University of Upsala to study medicine. When twenty-five years old, the Royal Academy of Sciences of that city encouraged Linnæus to make a journey to Lapland in the interests of natural science. At an early age he completed many important works. For example, there appeared his "Systema Naturæ" (1735), "Flora Lapponica" (1737), and "Genera Plantarum" (1737). As is well known, Linnæus' extensive collections of plants, insects, shells, and minerals, as well as his library and numerous precious manuscripts, passed into the keeping of the Linnean Society of London. In 1753, Gustavus, King of Sweden, created him a Knight of the Polar Star. By royal command a profile model in wax of Linnæus was made by Inlander in 1773. In this appears a sprig of the flowering plant *Linnæa borealis*. It is interesting in this connexion to mention that in a minute book of the Linnean Society, under date June 2, 1795, this little plant is recorded as discovered for the first time in Britain by Prof. James Beattie, of Marischal College, Aberdeen, in an old fir wood at Mearns, near Aberdeen.

The Physiological Society celebrated its jubilee by a dinner at the Hotel Metropole on Friday, May 13. The Society was founded in 1876, and its jubilee was in 1926, but owing to the amount of business resulting from the purchase of the *Journal of Physiology* from Mrs. Langley, it was not possible to arrange for the celebration in that year. The four surviving original members of the Society are: Sir David Ferrier, Sir E. Ray Lankester, Sir W. Thiselton-Dyer, and Sir E. Sharpey-Schafer, who presided at the dinner. The toast of the Society was proposed by Major Elliot, Parliamentary Under-Secretary for Health for Scotland, who pointed out the practical benefits that had been obtained as the result of physiological research. The chairman, Sir E. Sharpey-Schafer, in his reply, described how the Society was founded as a dining club to defend the members against the attacks of the anti-vivisection societies, and it thus represented the only good that had resulted from the anti-vivisection agitation. Later in the history of the Society it became customary to visit one laboratory or another before the dinner, to see demonstrations of work in progress. The development of the Society is shown by the present practice, namely, that demonstrations have precedence over other communications, and that all business, except that of a special general meeting summoned for some specific purpose, is transacted after the dinner which is held with most meetings of the Society.

Sir Charles Sherrington proposed the toast of the guests, with which was associated the names o Sir Ernest Rutherford, Prof. G. Fano, of Rome, Prof Gley, of Paris, and Viscount Knutsford. Sir Ernest Rutherford pointed out the relation between physics and physiology, in which a physical instrument was perfected for some special recording device such as the Einthoven string galvanometer, and was afterwards used in physical laboratories because of its delicacy and accuracy. He recommended a training in physics as a preliminary to research in physiology Prof. Fano made a delightful congratulatory speech in English, and Prof. Gley conveyed the best wishes of his French colleagues in a stirring address in French Viscount Knutsford referred particularly to the gain to humanity by Schafer's method of artificial respiration, and to the Research Defence Society, which does its best to educate the intelligent public as to the benefits obtained from experiments on animals. He suggested that physiologists ought to do their share by joining that Society, by furnishing accurate information, and by speaking on the subject. Pro Leonard Hill proposed a vote of thanks to the chairman, who, he pointed out, had sent apostles to Ireland, Canada, Australia, New Zealand, South Africa, United States, China, and many other parts of the world to promulgate the doctrines of physiology On Saturday, May 14, there was an ordinary meeting of the Society in Cambridge, with the business dinner meeting in Trinity College. On Sunday, Prof. and Mrs. Barcroft gave a garden party in the fellows' garden of King's College, kindly lent by the provost and fellows of the College.

The Admiralty announces in Fleet Orders that the recommendations of the International Conference held at Washington last year in connexion with oil pollution of navigable waters have been accepted in principle by the Government, and that the main recommendation, that oil should not be discharged within 50 miles of the coast, is being voluntarily adopted by British shipowners. This step will be welcomed by bird lovers and residents on the coast, where oil on the water and clinging to weeds and stones in the intertidal zone does increasing harm to the birds and to the amenities of the seashore. Among other provisions of the Convention—which takes effect as soon as the ratifications of five of the Governments represented at the Washington Conference of June 1926 have been notified to the United States Government—is that no dues based on tonnage are to be charged in respect of any space rendered unavailable for cargo by the installation of apparatus for separating oil from water. Upon the perfection and general adoption of such apparatus, a considerable amelioration of existing conditions may be expected.

The woods of Glencoin and Stybarrow, which overlook the head of Ullswater, are threatened with the axe. Energetic local action has been able to stay the danger pending the result of an appeal for funds to purchase the property. The public has responded generously, but approximately £600 is still required to make up the agreed sum, and the option expires on June 30. If the money be not raised by that time all the trees will be felled this autumn, to the grave loss of the amenity of the district, a recognised beauty spot in the Lake Country. If the purchase money be raised, the land and trees, comprising an area of 180 acres, will be presented to the National Trust or some similar body. The Committee makes a final appeal, which we endorse, for immediate contributions to meet the relatively small amount still outstanding; any donation will be gratefully received by the Hon. Treasurer, Mr. H. T. Roberts, Hawkhowe, Ullswater, Penrith.

A NEW annual archæological publication, to be entitled "Vestigia, or The Year's Archæology in Pictures," is announced. It will contain a comprehensive selection of photographic reproductions of discoveries made throughout the world in the course of each year. The first part will cover the year ending June 30, 1927. The contents will be entirely pictorial except for a general introduction by Mr. Stanley Casson. The Trustees of the British Museum have already granted a licence to reproduce illustrations relating to the expeditions under their control for a period of five years, and similar arrangements are being made in respect of the other more important excavations now being carried on elsewhere. The publishers are "European Books, Ltd.," Henrietta Street, London, W.C.2.

THE American Geophysical Union held its eighth annual meeting this year on April 28 and 29 at Washington. The programmes of the six sections were of considerable interest, and the report of the meetings should prove valuable and attractive. The sections of geodesy, and of terrestrial magnetism and electricity, occupied the first morning; the former was concerned with progress reports on geodesy in the United States and Canada, and discussions of world-longitude nets and variations of mean sea-level; the latter section discussed correlations of various radio phenomena with solar and terrestrial magnetic and electric activities. The first afternoon was devoted to the sections of oceanography and volcanology; the problems discussed by the latter range from the United States and Japan to the moon. On the following morning the section of meteorology held a discussion on measurements of the sun's ultra-violet radiation and of the ozone content of the upper atmosphere, while the section of seismology considered progress reports from various institutions, and some theoretical and instrumental problems. On the last afternoon the general assembly held a symposium on some factors of climatic control. The Union also arranged a week's exhibition of apparatus and other material bearing on geophysical research.

SILICA valves are now used by the Admiralty for radio communication. Silica has many properties which render it particularly useful in this connexion. It does not soften until its temperature attains about 1600° C. and it has a low coefficient of thermal expansion. The silica envelope is very diathermanous to the radiation from a red-hot anode, and so cooling by radiation can be adopted. This type of valve was discussed in a paper read on May 4 to the Institution of Electrical Engineers by H. Morris-Airey, G. Shearing, and H. G. Hughes. They pointed out that a most important constituent of the valve is the seal through which electrical contact is made between the electrodes and the external connexions. In the manufacture of the seal, lead is melted *in vacuo* in a thick walled silica tube. When this is done, it is found that the molten metal adheres firmly to the silica, forming a vacuum tight joint. As large currents are used when the tube is working, overheating is prevented by blowers supplying cool air continually to the seals. When valves are supplied with 15 kilowatts or more of electrical power, circulatory methods of cooling are adopted to prevent the radio office getting overheated. The heat energy from the anode is radiated through the silica envelope to a jacket containing a cooling fluid which is kept circulating by a pump. In internal cooling, the anode is made in tubular form and the cooling fluid is forced through the tube. This latter type of valve is still in the experimental stage; it has, however, many advantages. For example, a 4 kw. molybdenum anode has been used experimentally as a 40 kw. tubular spiral anode. Under working conditions, ninety per cent. of the failures of silica valves are due to a burn-out of the filament.

BEFORE broadcasting was introduced in Great Britain, many British radio amateurs used to listen to the Dutch broadcasting station at The Hague. Last March the radio station of the Philips' lamp laboratories at Eindhoven in Holland were in telephonic radio communication with Bandoeng in the Dutch East Indies. This development was made possible by using a short wave-length of 30 metres. In April the radio station at Sydney re-broadcast one of the Philips' programmes. Holland therefore is to be congratulated as the pioneer of long-distance broadcasting on short wave-lengths. The *Wireless World* for April 27 discusses the feasibility of Empire broadcasting. It seems certain that a short-wave British station of sufficient power to be heard for many hours a day throughout the British Empire could be built at no great expense. News could be broadcast and possibly Daventry programmes relayed at fixed times. This would perhaps be outside the scope of the B.B.C. and would have to be under the control of the Foreign Office and the Colonial Office. It would be a boon to many who have to live in lonely parts of the earth.

ON Friday, May 6, Air-Marshal Sir John Salmond unveiled at Cambridge a tablet to the memory of three pioneers in the application of scientific methods to aeronautical problems. Prof. Bertram Hopkinson, Dr. Keith Lucas, and Mr. Edward T. Busk all devoted great natural ability and mechanical inventiveness to the subject before they gave up their lives in their country's service. Bertram Hopkinson, professor of engineering and fellow of King's College, learnt to fly when more than forty years of age, that he might the better understand the problems connected with the bombs, bomb-gear, and aeroplane guns with which he was confronted in the Technical Department of the Air Ministry. Keith Lucas, fellow of Trinity College, one of the most brilliant young physiologists of his day, had made considerable progress in the development of air compasses when a collision in the air cut short a career of great promise. Edward Busk had already made notable contributions to the solution of the problem of the stability of aeroplanes, when in the very early days of the War he was killed when flying at Farnborough through his machine catching fire. It is well that their devotion and zeal should be commemorated in the headquarters of the Cambridge University Air Squadron, so that future generations may share in some slight way the admiration and high regard which their Cambridge contemporaries feel for them.

Sir Henry A. Miers delivered the seventeenth annual May Lecture before the Institute of Metals on Wednesday, May 11, taking as his subject, "Growth of Crystals." Sir Henry recalled experiments made twenty years ago by himself and Miss Isaac which seemed at that time to show that when a solution is cooled below its saturation temperature it passes into a 'metastable' state in which crystals can only be produced by introducing a fragment of the dissolved substance or of one isomorphous with it, and that at a lower temperature it passes into a 'labile' state in which crystals may appear spontaneously. Later investigations have shown that, in the metastable state, crystallisation can also be produced by shock. Sir Henry considers, however, that his experiments record the normal behaviour of crystallising liquids, and that crystallisation only takes place with some degree of supersaturation or undercooling. In his experiments there was always a sudden outburst of crystal growth at a definite temperature. Little importance is ascribed to undercooling by most geologists in their speculations concerning the crystallisation of molten magmas, but to many metallurgists it is a very important factor. The structure of alloys is in many cases attributed to a suspended crystallisation of this nature; not only as they solidify from the molten state, but also during the crystalline changes which take place in the solid alloy with change of temperature, for example in steel and in magnetic alloys.

A London meeting of the Prehistoric Society of East Anglia, under the presidency of Dr. R. R. Marett, will be held at the rooms of the Royal Anthropological Institute, by permission of the Council, on Tuesday, May 24, at 2.30 P.M. A number of papers will be presented and interesting exhibits shown. Mr. J. E. Sainty will report on the discovery of St. Acheul palæoliths at Whitlingham, Norwich, and Mr. Reid Moir will present a summary report on his recent investigations at Hoxne, Suffolk, where he has been excavating with the view of throwing further light on the problems of the boulder clay and its relation to types of palæolithic implements. An account of the 1926–27 excavations at Kent's Cavern, Torquay, will be given by Mr. H. S. Dowie. Miss Layard will exhibit microlithic flint implements from the Colne Valley, Essex, and implements in *grès lustré* from the Forêt de Montmorency. Mr. S. Turner will show exhibits from a late palæolithic site at Stone Cross Farm, Luton, Kent. In the evening the members have been invited to attend a meeting and conversazione of the Royal Anthropological Institute which will be held at the Wellcome Historical Medical Museum, by kind invitation of Mr. Henry S. Wellcome, when Prof. G. Elliot Smith will deliver a short discourse on the medical and magical aspects of the anthropological material in the Museum, and fellows and guests will be invited to inspect the collection.

The annual visitation of the Royal Observatory, Greenwich, will be held on Friday, June 3, when the Observatory will be open to inspection by invited guests at 3.30 P.M.

The Rev. T. E. R. Phillips, president of the Royal Astronomical Society, will deliver a lantern lecture on the coming solar eclipse, on May 27 at 8 P.M., at the Polytechnic, 309 Regent Street, London. The lecture is in aid of King Edward's Hospital Fund for London.

At the annual meeting of the Institute of Physics on May 16, the following officers were elected: *President*, Sir Frank Dyson; *Vice-Presidents*, Prof. C. L. Fortescue, Sir Richard Gregory, Mr. R. W. Paul, Mr. R. S. Whipple; *Hon. Treasurer*, Major C. E. S. Phillips; *Hon. Secretary*, Prof. A. O. Rankine.

The Prime Minister, Mr. Baldwin, showed his interest in optical work, and the importance he attached to the progress of the British optical industry, when he opened the very successful Optical Convention which was held in London in April of last year. The scientific work accomplished at the Convention has proved to be of wide interest and importance and has been recorded in the *Proceedings*, two substantial volumes running to more than a thousand pages. More than half of the edition originally printed has already been exhausted. Any inquiries with regard to the Convention and its publications should be addressed to the Secretary, The Optical Convention, 1926, 1 Lowther Gardens, Exhibition Road, London, S.W.7.

Applications are invited for the following appointments, on or before the dates mentioned:—A full-time lecturer in the mathematics and physics department of the Polytechnic, Regent Street, W.—The Director of Education, The Polytechnic, 309 Regent Street, W.1 (May 30). A head of the electrical engineering department of Robert Gordon's Colleges, Aberdeen—The Secretary and Registrar (May 31). A head of the building trades department of the Wigan and District Mining and Technical College—The Secretary of the College (May 31). A director of the Leeds Art Gallery—The Town Clerk, 26 Great George Street, Leeds (June 1). A surveyor of shipping under the Corporation of Trinity House—The Secretary, Trinity House, Tower Hill, E.C.3 (June 1).

A head of the mechanical engineering department, a head of the electrical engineering department, and a graduate assistant in the mechanical engineering department of the Rutherford Technical College—The Director of Education, Education Office, Northumberland Road, Newcastle-upon-Tyne (June 3). A biochemist, a soil chemist, and a plant physiologist at the University of Bristol Department of Agricultural and Horticultural Research, Long Ashton, Bristol—The Registrar (June 4). An assistant lecturer in the Commerce Department of the Belfast Municipal College of Technology—The Principal of the College (June 9). A principal of Battersea Polytechnic, and a woman head of the Department of Hygiene and Public Health—(1) The Clerk to the Governing Body, (2) The Principal (June 13). The Bernhard Baron research studentship at the Middlesex Hospital on the anatomy, physiology or pathology of the ear, nose and throat—The Secretary of the Middlesex Hospital, W.1 (June 14). A professor of botany in the University of Sydney, N.S.W.—The Agent-General for New South Wales, Australia House, Strand, W.C.2 (June 24). A lecturer in medieval history in the Queen's University, Belfast—The Secretary, Queen's University, Belfast (June 27). A biochemist, an assistant plant physiologist, and an assistant pomologist at the East Malling Research Station—The Secretary, East Malling Research Station, East Malling, Kent (June 30). Test assistants at the Royal Aircraft Establishment, South Farnborough, Hants (quoting A. 174). An assistant in the building trades department of the Halifax Municipal Technical College—The Principal, Municipal Technical College, Halifax. A senior physics master at Merchant Taylors' School, Crosby, Liverpool — The Head Master. Temporary Instructor Lieutenants in the Royal Navy — The Adviser on Education, Admiralty, Whitehall, S.W.1. A junior assistant chemist under the directorate of explosives research of the Research Department, Woolwich—The Chief Superintendent, Research Department, Woolwich, S.E.18.

ERRATUM.—At the end of Prof. Fritz Paneth's letter in NATURE of May 14, p. 706, on "The Transmutation of Hydrogen into Helium," for the date "Mar. 2" read "April 2."

Our Astronomical Column.

COMETS.—Comet Pons-Winnecke was an easy object for small telescopes early in May: both Dr. W. H. Steavenson and Mr. B. M. Peek noted a nearly stellar nucleus and a considerable coma. As the comet is steadily approaching both sun and earth, it should by now be quite conspicuous, but it is well to remember that while the position of comets can be predicted, their brightness is subject to capricious variations.

Dr. A. C. D. Crommelin has revised the orbit elements from observations on Feb. 25 and May 1 (by Merton), Mar. 4 (by van Biesbroeck). The period was assumed known; the other elements are:

$$\begin{array}{ll} T & 1927 \text{ June } 21{\cdot}0730 \text{ U.T.} \\ \omega & 170^\circ\ 17'\ 15{\cdot}3'' \\ \Omega & 98\ \ 12\ \ 34{\cdot}0 \\ i & 18\ \ 56\ \ 43{\cdot}2 \\ \phi & 43\ \ 16\ \ 22{\cdot}4 \\ \log a & 0{\cdot}5192415 \text{ (assumed)} \\ \log q & 0{\cdot}0168982 \end{array} \quad \left.\begin{array}{l} \\ \\ \\ \end{array}\right\} 1927{\cdot}0$$

Comet Grigg-Skjellerup is not likely to be so bright as Pons-Winnecke, but it is coming near the earth, so should be fairly easy to see. Its distance on June 3 is 19 million miles. Observations of position are desired.

H. Thiele has deduced elliptical elements of Stearns's comet, with a period of 9515 years, but departure from a parabola is not yet certain:

$$\begin{array}{ll} T & 1927 \text{ Mar. } 20{\cdot}02161 \text{ U.T.} \\ \omega & 10^\circ\ 36'\ 11{\cdot}5'' \\ \Omega & 214\ \ 35\ \ 43{\cdot}2 \\ i & 87\ \ 32\ \ 21\ 0 \\ \log q & 0{\cdot}565875 \\ e & 0{\cdot}991805 \end{array} \quad \left.\begin{array}{l} \\ \\ \\ \end{array}\right\} 1927{\cdot}0$$

Observations used were on Mar. 13, 26, April 5. It is fading slowly, but is still a fairly easy object.

Comet Comas Sola is getting rather low in the evening sky, but should be followed for as long as possible.

Ephemerides of these comets for 0^h follow; that of Pons-Winnecke is from earlier elements and will need some correction:

Comet.	Date.		R.A.			N. Decl.		log *r*.	log Δ.
Pons-Winnecke	May	20	15h	9m	20s	53°	16′	0·0532	9·4648
		28	15	21	0	54	26	0·0383	9·3716
	June	1	15	20	40	54	50	0·0320	9·3147
		5	15	42	8	55	1	0·0268	9·2485
		9	16	0	4	54	59	0·0225	9·1688
		13	16	27	28	54	19	0·0195	9·0712
Grigg-Skjellerup	May	20	7	58	5	31	33		9·3957
		22	8	9	53	35	6	9·9591	9·3757
		24	8	23	34	38	54		9·3572
		26	8	39	39	42	54	9·9656	9·3409
		28	8	58	49	47	0		9·3272
		30	9	21	55	51	6	9·9736	9·3171
	June	1	9	50	2	55	0		9·3106
		3	10	24	5	58	30	9·9820	9·3080
		5	11	4	34	61	20		9·3095
Stearns	May	23	14	19	47	17	48	0·5715	0·4680
		31	14	13	31	19	32	0·5728	0·4820
	June	8	14	8	17	20	57	0·5743	0·4976
		16	14	4	11	22	5	0·5760	0·5139
Comas Sola	May	24	7	36	20	31	57	0·2730	0·3741
	June	1	7	59	32	31	4	0·2790	0·3873
		9	8	23	16	29	52	0·2855	0·4004

RECENT SUNSPOT ACTIVITY.—A large group of sunspots, recently in transit across part of the sun's disc, was the first to be seen with the naked eye since last January. In the interval of four months a number of smaller groups have been seen, averaging at least six daily, but there has been a noticeable absence of very large spots which are usually fairly frequent at this time of the solar cycle. The recent group, consisting of a pair of large, roughly circular spots, began as a tiny spot seen on May 9, and its rapid growth is well shown by the following measures of area, in units of millionths of the sun's hemisphere, made at intervals of approximately 24 hours:

Date	May 9	10	11	12	13	14
Area	5	150	380	870	1000	1350

One interesting feature of the group was the invariable distance apart, 6° in longitude, preserved by the two spots; in the majority of such groups the early rapid growth is associated with a considerable drifting apart of the two chief components, so that at maximum development they are separated by at least 10° in longitude. Other details of this group are given below in the usual manner:

No.	Date on Disc.	Central Meridian Passage	Latitude	Max. Area
4	May 9-17	May 11·7	17° N.	1/800 of hemisphere.

Research Items.

THE PICTORIAL RECORDS OF DAHOMEY.—The Institut d'Ethnologie of Paris has inaugurated a series of publications of its own, to be known by the general title of "Travaux et Mémoirs," with two volumes dealing with primitive art. Of these the first, by M. E. M. G. Waterlot, is a description, fully illustrated, of the bas-reliefs of the royal buildings of Abomey (Dahomey). The interest of these polychrome bas-reliefs is dependent not only on their æsthetic qualities but also on the fact that they are historical records of achievements of the king in whose reign they were executed, or of events which took place in that reign. The occurrence in Africa of historical documents of this type, of undoubted authenticity, is a matter of very considerable interest to ethnologists. The drawings here described, of which reproductions have been made for the Musée d'Ethnographie de Paris, are taken from the palace of Agadja (1708-28), of Ghezo (1818-38), and Glélé (1838-1889). As the country over which they ruled had been conquered by their people in the early seventeenth century, and was held by force of arms, these pictorial records not unnaturally deal mainly with their struggles with neighbouring peoples and the punishments meted out to the vanquished. In addition are religious symbols, records of notable dicta of the kings, or allegorical representations of the kings themselves. They are found only on the walls of the private apartments of the kings; they were not found in other parts of the palaces, even in those portions reserved for the mothers of the kings or their representatives, or for the old women to whom was entrusted the guardianship of the tombs of the kings and of the sacred objects of the tribe.

NEW CALEDONIAN ART.—The second of the *Mémoirs et Travaux de l'Institut d'Ethnologie*, Paris, is a study of New Caledonian art by M. G. H. Luquet, based to a great extent upon material collected by Marius Archambauld. M. Luquet, whose studies of prehistoric and primitive art have won him a position as a recognised authority, has analysed the material from the viewpoint of an æsthetic critic and psychologist. After a detailed examination of the specimens and a classification of the motives found in both the petroglyphs and the engravings on wood or bamboo, he concludes that the characteristic feature of the petroglyphic art is not so much the cross in its various forms, as was thought by Archambauld, as the representation of the stylised human form and especially the human face. Nor is he able to agree with Archambauld that the petroglyphs represent the art of a vanished race. They are merely one manifestation, the earliest, of what is essentially a single artistic activity with identical motives, identical spirit, the same tendencies, and the same æsthetic surviving even down to the present day, given certain modifications due to difference in material, and changes in objects represented on the introduction of European civilisation. The proportion of engravings with a religious motive is probably small. The strongest impulse to artistic representation is probably purely æsthetic, with a strong tendency to intentional stylisation, rather than the result of a schematisation due to repeated or careless reproduction of a motive originally realistic. New Caledonian art would appear to afford no support to the view that naturalistic art belongs to hunting peoples, while schematic art is the product of an agricultural mode of life.

VITALITY OF YOUNG ANIMALS.—Mr. E. L. W. Heck, of Cambridge, Mass., in a letter to NATURE, states that in certain experiments relating to the educability of the albino rat, rats from the age of 21 days are trained to avoid an electric shock. During the first two or three days of training the shock seems to have very little effect upon them, but thereafter its effects become progressively more pronounced, so that after two weeks have passed it is not uncommon for the rats to be killed by the shock. For this reason it was found that the greatest care had to be exercised during the fourth and final week of training. These observations, if confirmed, are of interest, since they are opposed to the general conclusions reached by Child, whose experimentation showed quite clearly that with reference to narcotics generally, young animals beyond a certain stage of growth show the highest susceptibility, and that this susceptibility decreases with advancing development. The swing in the degree of susceptibility is related to a change in metabolism from a higher to a lower level.

THE DISTRIBUTION OF ANOPHELINE MOSQUITOES IN SCOTLAND.—In the *Proceedings of the Royal Society of Edinburgh*, vol. 47, Part I. (No. 6), 1927, Prof. J. H. Ashworth discusses this subject and provides some new records. In Scotland the available evidence indicates that *Anopheles bifurcatus* is the most abundant and widespread species, whereas in England *A. maculipennis* predominates. So far, the latter species has been met with only in four localities in the Highlands, while *A. plumbeus* occurs over a considerable portion of the eastern coastal region of Scotland. Details of the only case of indigenous malaria in Scotland since that disease became compulsorily notifiable in 1919, are quoted from the Report for 1919 of the Medical Officer of Health for Glasgow. A woman patient suffering from malaria had resided at Kirriemuir (Forfarshire) at a time when troops were present, and it is surmised that she was bitten by a mosquito which had acquired the malaria plasmodium from an infected soldier. The results presented in this paper constitute data for commencing a survey for Anopheles in Scotland, and the paucity of records of the genus in that country is merely an indication of the small amount of attention that the subject has yet received. It is noteworthy that such records as do exist tend to congregate where observant collectors reside, namely, around Edinburgh and Glasgow.

THE SHOT-HOLE BORER OF TEA.—The Shot-hole Borer (*Xyleborus fornicatus*) has been considered one of the worst pests of tea in Ceylon for the past twenty years. During the last half of this period almost every possible control method has been examined and various recommendations have been made, but without the desired result being achieved. In Bulletin No. 78 of the Department of Agriculture, Ceylon, Messrs. F. P. Jepson and C. H. Gadd discuss manuring in relation to the control of this insect. In Part I of this Bulletin (by Mr. Jepson) it is stated that some measure of relief from the depredations of the Shot-hole Borer might be expected from the adoption of special cultural methods and the utilisation of natural enemies. It is with the first method that this Bulletin is concerned, and extensive experiments were set up in order to ascertain the relative values of nitrogen, potash, phosphoric acid, and lime in the control of the pest in question. The interpretation of the results of these trials form Part 2 of the Bulletin (by Mr. Gadd). It appears that none of the treatments exercised any direct effect on the beetles, and the main benefit derived from the application of manure was the accelerated healing of the galleries bored by the insects in the tea plants.

The healing was most marked in the plots treated with nitrogenous manures, this process being complete in 2·9 months, whereas in the control plot healing was not complete until after 3·75 months. It is concluded that the manuring of tea offers a satisfactory method of diminishing the effects of attack by the Shot-hole Borer. Manuring for this purpose should aim at increasing the nitrogenous content of the soil.

Copper Dusts and Sprays for Potatoes.—The results of trials undertaken to determine the relative efficiency of certain copper dusts and sprays in the control of potato diseases and insect pests are published by O. C. Boyd in Bulletin 451 of the Cornell University Agricultural Experiment Station. With light applications it was found that Bordeaux spray mixture covered a larger area than copper-lime dust containing equivalent copper per unit area, owing to the greater number and surface area of the spray membranes. Retention of the copper also was considerably greater on the sprayed than on the dusted foliage, though the dust adhered better if the potato foliage was thoroughly moistened, and consequently the effectiveness of the dust in disease and insect control was thereby improved. The use of Kayso, a casein spreader, did not increase the adhesiveness of either copper-lime dust or two Bordeaux powders, but it effectively increased the spreading powers of the spray. As regards disease and insect pests, under good working conditions, early and late blight and aphid attack were equally well controlled by copper-lime dust or Bordeaux spray mixture containing equivalent copper, though the spray proved superior in the case of flea beetles, leaf-hoppers, and tipburn. The addition of nicotine to the copper-lime dust increased the effectiveness of this substance against aphids, but an addition of sulphur was useless. Leaf injury resembling that induced by spraying blue vitriol on dry foliage occurred with copper-lime dusts containing 10 per cent. or more copper; lower quantities, however, were not harmful. Heavy applications, whether as dust or spray, were deleterious to plant growth apart from local leaf injury, and mechanical damage by machinery was to some extent unavoidable. The preference seems to be for the use of sprays rather than dusts, the average plant yield on sprayed plots being higher than that of dusted ones, and further, the cost of spraying was slightly less than that incurred with home-mixed copper-lime, and considerably less than when commercial dusts were employed.

Phytogeography of Greenland.—C. H. Ostenfeld has added two more papers to his list of publications on the vegetation of Greenland (*Saertryk af Meddelelser om Grønland*, 68, and *Det. Kgl. Danske Videnskabernes Selskab., Biologiske Meddelelser* 6, 3, 1926). The former memoirs dealt for the most part with the floras of specific localities in Greenland; the two papers just issued now collate and focus the results of the author's several years' investigations and give a comprehensive survey of the whole problem. The immigration of the flora of Greenland has been the subject of discussion by many authors, including such eminent workers as Hooker and Warming, but the knowledge and experience of Dr. Ostenfeld in the field of phytogeography in general and in that of the Arctic and sub-Arctic regions in particular, make his conclusions of a high degree of importance. The author's 15 phytogeographical districts are populated by 390 species of vascular crytogams and phanerogams, falling into three categories, high Arctic, Arctic, and sub-Arctic to boreal. He considers about sixty species as having survived from pre-glacial times somewhere in Greenland, and this may account for the occurrence of some of these species in Arctic countries of both the eastern and western hemispheres. Of the remaining species he comes to the conclusion that 74 are immigrants from Europe, the majority having been introduced by Norse settlers not more than nine hundred years ago. The other 256 species must be regarded as having come from America. In this connexion, among immigration routes, special attention is directed to the narrow Smith Sound and Kennedy Channel route to the north-west. On account of the fact that a post-glacial heat maximum existed, this route could have been followed by more southerly species than at the present day. Mention is also made of immigration from the north-east with the drift ice of the polar current. For the rest, immigration must have been effected by wind and birds carrying seeds across the sea. Special importance probably attaches to the action of the wind in winter, when seeds and portions of plants can be swept along over the frozen straits before the storm. It is considered unnecessary to assume any post-glacial land connexions to the west and east.

Destruction of Icebergs.—Some interesting records of the effect of the application of high temperatures on icebergs are to be found in an article by Prof. H. T. Barnes in the *Marine Observer* for May. The rapid destruction of icebergs is best effected by the production of an internal disruptive force. In order to produce this force Prof. Barnes used thermit as the explosive, by which a very high temperature can be produced at a selected spot. His experiments were carried out in Notre Dame Bay, Newfoundland, on drifting bergs. One berg was about 100 feet above the water line and 500 feet long by as many wide. The berg appeared to be solid and fresh. A hundred pound charge was let into the ice in a 3-feet boring. The immediate effect of the explosion was much audible cracking and some visible disruption, but it was not until the next day, and the day following, that the full effect of the disruption was visible. Photographs show that within two days the berg, though still formidable, had been very much reduced in size. A smaller berg, about a hundred feet in diameter, was practically destroyed within twenty-four hours by the use of two charges of thermit fired simultaneously.

Tectonics and Petrogenesis.—The attention of petrologists is directed to an important monograph by Prof. W. N. Benson on "The Tectonic Conditions accompanying the Intrusion of Basic and Ultrabasic Igneous Rocks," which is published in the *Mem. Nat. Acad. Sci.*, vol. 19, No. 1, 1926. A world survey of the rocks concerned is made and a provisional tectonico-petrographic classification is suggested. The suites or kindreds that are recognised include the following: the *green rocks* of the Alpine type associated with planes of shearing in former geosynclinal zones; the *spilites* formed on the margin of geosynclines; *laccomorphic complexes* such as those of Sudbury and the Bushveld in which there is no dominating lateral pressure; *cordilleran complexes* in which lateral pressure is a controlling factor; the *dolerite sills*, a uniform group invading broad areas of approximately horizontal strata; the *alkaline plateau group* in regions of vertical block-faulting; and the *alkaline peridotite* dykes related tectonically to the last-mentioned suite. It is concluded that each suite is very generally associated with a definite set of tectonic conditions, and the importance of the latter in determining the morphology of igneous masses and in controlling the processes of magmatic differentiation is emphasised.

Petroleum in Persia.—In January last, at a meeting of the Royal Society of Arts, Sir John Cadman gave an interesting account of the development of the petroleum industry in Persia (*Jour. Roy. Soc. Arts.*). So far back as 1872 de Reuter endeavoured to locate oil in that country, but without success; there followed the activities, in the early 'nineties, of the Persian Mining Corporation, which sank two wells at Daliki, not far from Bushire, in the neighbourhood of an oil seepage, but this also proved abortive. W. K. D'Arcy, with whom the beginnings of the Persian oil industry will always be associated, started operations in 1901 and acquired from the Persian Government a concession which covered the greater part of southern Persia; early efforts to locate a commercial store of oil were most discouraging, and it was not until 1908 that the great Persian field was first proved by the bringing-in of a gusher at Masjid-i-Sulaiman, a valley in the Bakhtiari Hills, some hundred and fifty miles from the head-waters of the Persian Gulf. The formation of the Anglo-Persian Oil Company came about in the following year, since when the remarkable development of this great oilfield is a matter of common knowledge. To-day Persia occupies fourth place on the list of oil-producing countries, having an annual output of more than 4,500,000 tons; the proven area of the field is great, in length more than twenty miles, but there is still much unproven and potentially good territory. From the small initial staff (scarcely a score in number) responsible for early developments, the personnel has now swollen to literally a multitude, more than 1000 Europeans, 3000 Indians, and 25,000 Persians being employed. This in itself conveys some idea of the magnitude of operations of the Company in Persia and of the rapid growth of a great industry.

Teeth of Cretaceous Mammals.—In the March issue of the *Scientific Monthly*, Prof. W. K. Gregory has published a further account of the very important Cretaceous mammals found in Mongolia by the expedition of the American Museum of Natural History. The article is semi-popular and is of general interest. There are good illustrations of the locality where the finds occur and figures and diagrams of the specimens. For the specialist, the chief interest is in the clear explanation and diagrams of the author's view as to the evolution of the teeth. The old Cope-Osborn tritubercular theory becomes considerably modified in that the 'protocone,' which was thought at one time to represent the original reptilian cone, is now shown to be a secondary cusp. The original single cusp is shown to divide into the paracone and metacone, and the tritubercular tooth is formed not by a rotation of secondary cusps anterior and posterior to the central one, but by a growth inwards from the divided chief cone of a spur on which the so-called 'protocone' arises.

The Specific Heat of Hydrogen.—Dr. F. Hund's second paper on the significance of band spectra (*Zeitschrift für Physik*, 42, p. 93, 1927) deals in addition with the closely allied problem of the specific heat of hydrogen between the high temperature region where both rotation and translation occur, and the low temperature region where the former is practically absent. The relative statistical weights of the members of either odd or even rotational quantum levels can be predicted from theory, but there is no correlation between odd and even terms. Comparison of theory with experiment is rendered difficult because the moment of inertia of the molecule is also unknown. The form of the specific heat-temperature curve can, however, be predicted if even terms are assumed to be an arbitrary factor (*f*) times as frequent as odd terms, and the position of the curve can then be fixed by choosing a moment o inertia so that the empirical and theoretical values o the specific heat are the same at the convenient temperature of - 77° C. The factor *f* is then found by observing which of the theoretical curves agrees best with the experimental measurements. The most concordant results are obtained with *f* equal to 2, but it is not possible to specify it exactly. The moment of inertia can nevertheless be determined fairly closely, and would only have to be increased by 10 per cent. if even rotational terms were three times as probable as the odd, instead of being twice as probable.

Colouring of Metals by Polishing.—J. A Wasik, of the Physical Laboratory at the Polytechnic Institute, Warsaw, communicates the following observations made by him subsequent to his work on the electrical conductivity between polished metal surfaces (see also his papers in *Zeit. f. tech. Phys.*, 5, 29-31, 1924; *L'Onde électrique*, 35, 535-541, 1924; *Zeit. f. Phys.*, 3, 720-21, 1926). In preparing flat polished surfaces of metal, using aluminium oxide as polishing powder and base blocks of different materials such as pitch, glue, shellac, or lime, coloured layers were found to be produced on the metal surfaces, provided the polishing powder was sufficiently fine. Thus with iron the colours gold-yellow, brown, nearly black, clear blue, and green were obtained, the most difficult colour to obtain being that of the metal itself. These layers resist oxidation very well and several of them show exceptional resistance to the action of acids. They differ much in hardness and elasticity. M. Wasik considers that the colours obtained cannot be explained by oxidation or by interference effects, as they undoubtedly depend on the material of which the polishing base block is made, and probably on the nature of the surrounding gases; they are differently disposed (on the surface) from the oxidation colours often obtained with cloth polishing. He believes that the coloured surface films are of the nature of isotropic vitreous enamels filling the interstices between the metal grains, covering the surface and giving it lustre (reference is made to the amorphous Beilby layer); and he suggests that attention should be turned to various phenomena connected with the polished surface of metals, for example, the Kerr effect.

Magnetic Research.—The issue of *Science Progress* for April contains an article on recent developments in magnetism by Dr. E. C. Stoner, which will prove very acceptable to those who have not the time to read Dr. Stoner's recent book on the subject. Starting with the electron rotating about a positive centre of force, he shows how an atomic system in which the magnetic moments due to the electrons balance out will behave diamagnetically, while if they do not balance out it will be paramagnetic. The effects of temperature are then dealt with, and finally the conception of the molecular field is introduced to account for the properties of ferromagnetic substances. On these general principles as a basis, the author goes on to recent work on the magnetic properties of atoms and ions, dealing in particular with the magnetic deflexion of the atoms streaming from heated metals, and with the atomic moments of iron, nickel, and cobalt, and the magnetic properties of crystals. Dr. Stoner does not think that the spinning electron theory helps forward magnetic theory to any great extent, nor does he appear to abandon atomic models in favour of the matrix method or of the undulatory mechanics method of dealing with the properties of the atoms.

Land in the Arctic.

THE study of the Arctic tides attracted wide attention when Harris concluded from his stationary wave-theory in 1911 that an extensive area of land existed within the unexplored area of the Arctic regions. Nansen, on the contrary, inferred the existence of a deep Polar basin from his observations in the *Fram* between 1893 and 1896.

Harris's hypothetical land gave a stimulus to explorers, but their search was fruitless. Stefanson, on his remarkable journeys over the sea-ice north of Alaska, and McMillan on this Crocker Island expedition, both touched the outskirts of the unknown region without finding anything but broken sea-ice. Amundsen in 1926 passed over the central part of the unexplored region in the dirigible *Norge* without seeing any land. Between 1918 and 1925 the *Maud* expedition made numerous tidal observations in the area north of Siberia. These observations, combined with earlier data, have been critically examined by Sverdrup and indicate in this area a tidal wave of the progressive type, differing from the stationary type deduced by Harris; nor do they indicate the existence of any extensive masses of land within the unexplored region.

The illustration here reproduced (Fig. 1) from Sverdrup's papers[1] shows the cotidal lines (the times of high water, in terms of Greenwich lunar time at full and new moon), and indicates that the progressive tidal wave from the north Atlantic enters the opening between Greenland and Spitsbergen and crosses the Arctic Sea without meeting any obstruction caused by extensive land masses. The figure reveals that the tidal wave reaches De Long's Island five hours before it reaches Point Barrow, although the direct distance from the Spitsbergen opening to the Island and to Point Barrow is nearly the same. This suggests a shallow sea in the unexplored region north of Wrangel Island and Point Barrow, with perhaps islands in places.

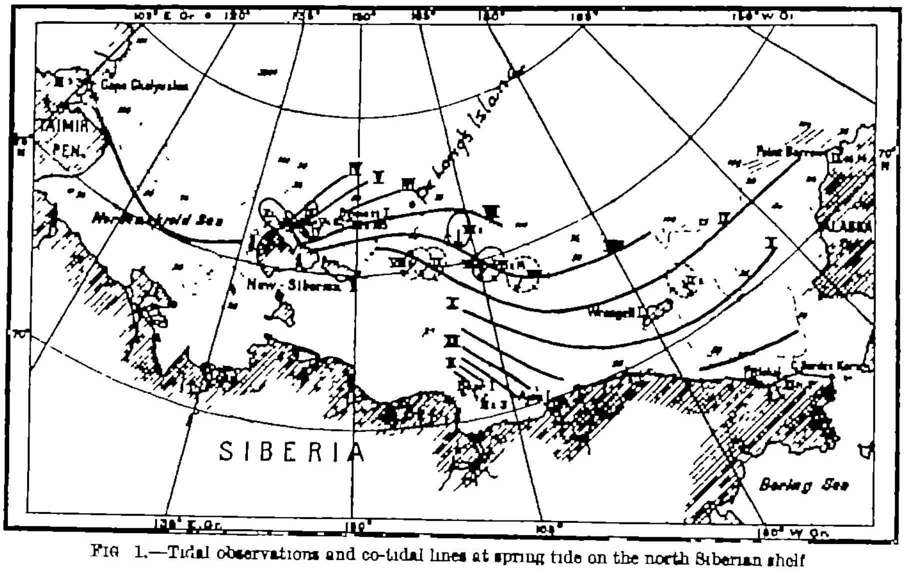

FIG 1.—Tidal observations and co-tidal lines at spring tide on the north Siberian shelf

The tidal streams met with were of the rotary type usual in open ocean areas, but they present a striking peculiarity. Below the ice to a depth of some twenty fathoms water of the same density is present, while below this there is a sudden increase in density and later a slow increase on approaching the bottom. In the water layer of equal density the tidal streams ran slow, but in the layer where density increased rapidly with depth the tidal streams were at a maximum, dying away towards the bottom.

The water can be considered as composed of three layers of different eddy-viscosity. In the upper layer of equal density vertical eddies are free to be developed and the eddy-viscosity or 'virtual' viscosity is great. In the intermediate layer of rapidly changing density vertical motion is restrained and the eddy-viscosity is low, while below this, where there is a slower increase in density, the eddy-viscosity is of an intermediate value.

H. W. H.

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[1] "The Tides on the North Siberian Shelf: their Bearing on the Existence of Land in the Arctic Sea and their Dynamics," H. U. Sverdrup, *Journal of the Washington Academy of Sciences*, vol. 16, pp. 529-540 (Washington, Dec 1926).

The Initial Phase in Gaseous Explosions.

WHILE an atmosphere of controversy is not perhaps the best for the calm interpretation of scientific facts, there is no doubt that the clash of opinions gives a zest to research and sometimes speeds up discovery. The slow uniform movement of flame in the initial phase of the explosion of gases—first studied by Le Chatelier—has given rise to such a controversy between Prof. W. A. Bone and his colleagues at the Imperial College of Science and Technology, South Kensington, and Prof. R. V. Wheeler and his colleagues at the Safety in Mines Research Laboratories at Sheffield.

There is no doubt that many explosive mixtures, when lighted at the open end of a long tube, burn with a slow uniform movement for a certain distance, and as a rule this uniformity is more marked the slower the propagation of the flame. When 'limit' mixtures of various saturated hydrocarbons with air, *i.e.* mixtures which would just propagate flame, were ignited at the open end of a tube, Prof. Wheeler and his colleagues found that the flame had an initial uniform movement which was the same for each mixture; and, moreover, when any two of these mixtures were mingled together, the complex was also a 'limit' mixture and burnt at the same rate. So far, we understand, the speed-law is unquestioned. But when the law is extended to non-limit mixtures and to all gaseous mixtures of the same type (*i.e.* with either excess of combustible or excess of oxygen), which have the same uniform speed of flame, the two schools are in disagreement. Prof. Bone (with Messrs. Fraser and Winter) has just published in the *Proceedings of the Royal Society* photographs of the flames initiated in ethylene-oxygen, acetylene-oxygen, and in hydrogen-oxygen mixtures. He finds that such fast-burning mixtures do not always show any uniform movement, and sometimes give in successive experiments uniform movements of different speeds. No doubt such mixtures are very sensitive to slight changes in the application of the igniting flame and the possible setting up of turbulence, and the length of the tube might affect the result.

Experiments to test the speed-law with blends of an ethylene-oxygen and a methane-oxygen mixture respectively with an hydrogen-oxygen mixture gave results which fell progressively below the predicted rates according as the hydrogen mixture was increased in the blend. It has been pointed out, on the other hand, that the rate of chemical change (and therefore the spread of the flame) is subject to the law of mass-action; the curve predicted by the speed-law diverging from the experimental speeds as the combustible gas approaches the upper limit of propagation. The speed-law has some exceptions, evidently: do they prove the rule?

In Part 3, Prof. Bone (with Messrs. Fraser and Witt) shows photographs of the initiation of the explosion of an equal mixture of methane and oxygen in the centre of a closed tube under the influence of sparks varying in character and intensity. With the feebler sparks there seems to be a short period of 'induction' with no visible flame; then a 'ghost-like' flame spreads with acceleration until it is checked before it reaches the ends of the tube, and finally there is the intense illumination traversing the whole column of gas in waves from end to end. With the intenser sparks the flame spreads at once and luminous striæ describe wavy paths within the ghost-like flame. The very luminous waves are caused by reflections from the closed ends: they are not shown when the ends of the tube are opened before firing. The powerful sparks evidently provoke rapid combustion in their neighbourhood.

A University Centre in London.

A MOST important announcement in relation to the future of university education in London was made at the Graduation Dinner of the University on May 11. Aided by a grant from the Government and a generous gift from the Rockefeller Foundation, the university has been able to arrange for the purchase of the Bloomsbury site of 11 acres, including roads, or 8½ acres excluding roads, north of the British Museum. This site was purchased by the Government in 1920 and offered to the University under conditions which the University was unable to accept, with the result that after five years the site was re-sold to the vendor, the Duke of Bedford, in accordance with the terms of the conveyances.

The Vice-Chancellor, Sir William Beveridge, indicated some of the purposes for which the site will be used, including University offices, Senate House, Library, Ceremonial Hall, Examination Hall, the Institute of Historical Research, a Faculty Club for Teachers, a Students' Union, O.T.C. Headquarters, perhaps one or two colleges, and finally, the beginning of residential quarters for teachers and students. He described in eloquent terms his vision of the future University of London, and appealed for the inspired artist who would embody it in stone and steel, "who will bring into the very heart of London a group of buildings that, raising their towers and pinnacles to the sky, will form a shrine of youth and learning in Bloomsbury to rank with the shrine of our history and our liberties by the Thames at Westminster." Lord Eustace Percy, President of the Board of Education, who was the guest of honour at the dinner, said that the announcement marked a great and historic moment in the history of the University. It will be generally hoped that the change of home will mean a change of heart, and that the feuds and wrangles of the past will soon become a fading memory. "The final decision," the Vice-Chancellor said, "was unanimous and is a pledge of unity for the future."

As to new developments for scientific research, no information was forthcoming. The general policy of university research institutes is still an open question the discussion of which should now, however, take a new orientation; and a claim to part of the site will no doubt be advanced on behalf of sciences for which at present research facilities are inadequate. Provision should also be made for public university lectures. Referring to the financial position, the Vice-Chancellor said that, after purchasing the site, there was money in hand for the Central Offices. "The rest must wait for further help." The amount of the munificent contribution from the Rockefeller Foundation was not divulged

University and Educational Intelligence.

Cambridge.—By the will of the late Prof. A. W Scott, of Lampeter College, the University is to receive £7000 and a third of the residue of his estate approximately a further £4000, for the furtherance of physical science.

Sir Josiah Stamp will deliver the Rede Lecture on June 8 on "Stimulus in the Economic Life." Prof A. E. Taylor, of Edinburgh, will deliver the Leslie Stephen Lecture on June 3, on "David Hume and the Miraculous."

Mr. J. E. Purvis, Corpus Christi College, has been re-appointed University lecturer in chemistry and physics in their application to hygiene, and Mr. A Hopkinson, Emmanuel College, has been re-appointed demonstrator of anatomy.

London.—Applications are invited for the University studentship in physiology, value £50, which is open to a student qualified to undertake research in physiology. The latest date for the receipt of applications by the Academic Registrar, South Kensington, S.W.7, is May 31.

Manchester.—An anonymous donor has given about £5000 for the endowment of two post-graduate scholarships for research in plant and animal biology.

Oxford.—The University statutes have been modified to enable the committee for advanced studies to make grants of money for equipment needed by students for the degree of B.Sc.

The great and rapid development of the School of Rural Economy and of the various agricultural institutes affiliated to it from 1908, when it began with a modest grant of £800, to the present time when it has received a total grant of £44,000, has determined the passing of a new statute to redefine and strengthen the functions and powers of the Committee for Rural Economy. The Committee will have general control of the available funds, and will appoint directors and research officers for the two institutes for research in agricultural economics and agricultural engineering and for the advisory institute.

A new medical travelling studentship has been founded in memory of Dr. George H. Hunt. The value will be somewhat less than £100 every other year. Candidates must be graduates in medicine who shall have not exceeded five years from the date of passing their final M.B. examination; they will be expected to travel abroad for a period of not less than three months for clinical study or medical research, and eventually to engage in practice as surgeons or as general practitioners.

Prof. C. A. Edwards, professor of metallurgy and acting-principal of the University College of Swansea, has been appointed Principal of the College in succession to Dr. Sibly. Prof. Edwards will continue to act as professor of metallurgy and will supervise the work of honours students and direct research in the department.

Applications are invited by the London County Council for two Robert Blair fellowships in applied cience and technology, each of the value of £450 and enable for one year. Applicants must be British ubjects and not less than twenty-one years of age. Particulars and application forms (T.2.a./300) are obainable from the Education Officer (T.2.a.), the County Hall, S.E.1. Forms must be returned by June 18.

The Ramsay Memorial Fellowship Trustees will onsider, at the end of June, applications for a Ramsay Memorial Fellowship for chemical research. The value of the fellowship will be £250 per annum, o which may be added a grant for expenses not exceeding £50 per annum. Applications must be eceived not later than June 6. Full particulars as o the conditions of the award are obtainable from he Secretary, Ramsay Memorial Fellowships Trust, University College, London (Gower Street, W.C.1).

At a meeting of Armstrong College Council held on May 16, the resignation was accepted with regret of Prof. J. W. Bews, professor of botany. Prof. Bews, who came to Armstrong College from University College, Natal, in January 1926, has found the English climate unduly trying for both his wife and himself after fifteen years' residence in South Africa, nd he is returning to his old post in Natal. The Council has appointed Mr. J. W. Harvey to be professor of philosophy in succession to Prof. A. S. Ferguson, now Regius professor of logic in the University of Aberdeen. Mr. Harvey, who is at present a lecturer in philosophy at the University of Birmingham, was educated at Rugby and Balliol College, Oxford; he has also studied in Berlin and Marburg. He is the English translator and editor of Prof. Rudolf Otto's "Das Heilige," which appeared under the title "The Idea of the Holy," and has ollaborated with others in a small book entitled "Competition: A Study in Human Motives," published in 1913. Mr. Harvey is a member of the Society of Friends.

The project of a university college at Hull, and the steps taken towards realising it, are described by the principal—Prof. A. E. Morgan, formerly of the University of Sheffield—in the April number of the *University Bulletin*. It is hoped that building operations will be started during the summer of this year, but it is doubtful whether the college will be ready to open its doors to students before 1929. The issue also contains an exceedingly interesting etter from Prof. G. S. Brett, of the University of Toronto, on university education in Canada. "The two vital questions seem," he says, "to be numbers and politics. If numbers steadily increase a special effort must be made to distinguish between genuine students and those who merely 'go through' the university. This effort will depend in the last resort on the attitude of those who pay the bill; if they have wisdom and know the value of educational deals for a country, the otherwise inevitable degeneration will be avoided." The operations of the Anglo-German Academic Board in developing a system of interchange of university graduate students between Germany and England are described, and the address of the president of the Association sums up the work standing to the credit of the Association.

Calendar of Discovery and Invention.

May 22, 1724.—The total solar eclipse which occurred on May 22, 1724 (May 11, O.S.), was the last total eclipse seen in England. A copy of Halley's map of the path of the shadow crossing Ireland, south-west England, France, and southern Germany is to be seen in the Astronomical Gallery at the Science Museum. The eclipse was observed by Maraldi and J. Cassini at Trianon and by Delisle at Paris. At Trianon the period of totality was 2 minutes 16 seconds. Venus, Mercury, and a few of the fixed stars were visible to the naked eye, and it was noted that "a corona of light was seen to encompass the dark body of the moon during the totality of the eclipse." According to a note in Nature of April 29, 1875, p. 507, an account of the eclipse was given in Stukeley's "Itinerarium Curiosum."

May 22, 1735.—Though Galileo, Halley, and Hooke had discussed the air currents of the world, George Hadley was the first to study adequately the direction of these currents, his views being given to the Royal Society on May 22, 1735, in a paper entitled "Concerning the cause of the General Trade Winds." It was, however, many years before the value of his writings was recognised.

May 24, 1753.—Carl Linnæus, the Swedish naturalist, published the first portion of his celebrated "Species Plantarum," in which he brought into use his "nomina trivialia," or two names, generic and specific, in place of the cumbrous sentences previously employed; the first part consisted of pages 1-560; the rest came out in the month of August.

May 24, 1844.—In 1843 the Senate of the United States voted 30,000 dollars to enable Morse to erect an experimental electric telegraph line between Washington and Baltimore. On May 24, 1844, the first public exhibition of the working of this line took place. Sitting in the Supreme Court of the Capitol in Washington, Morse signalled the words, "What hath God wrought," the message being received and repeated by Alfred Vail at Baltimore.

May 25, 1812.—Davy's beneficent work on the study of mine explosions and the invention of the miner's safety lamp were the direct outcome of the disastrous explosion at Felling Colliery, Sunderland, on May 25, 1812, when 92 lives were lost.

May 26, 1798.—Among many ingenious methods of raising water is that of the hydraulic ram devised by John Whitehurst of Cheapside about 1770, but improved and made automatic by Montgolfier, who patented it in France on May 26, 1798, and was awarded a gold medal at the French Exposition of 1802.

May 27, 1846.—For many centuries the only explosive in use was gunpowder. The first of the modern explosives to be introduced was gun-cotton, discovered by Schonbein and described by him to the Scientific Society of Basle on May 27, 1846. There are, however, earlier references to it in Schonbein's letters to Faraday. In October 1846 the British Government voted £1500 for experiments with the new explosive.

May 28, 1898.—Among the important investigations carried out at the Royal Institution, few have surpassed in interest those on the liquefaction of gases initiated by Faraday in 1823 and continued sixty years later by Dewar. Cailletet first saw liquid oxygen in 1877, and Olszewski also liquefied it in 1883. Fifteen years later, on May 28, 1898, Dewar obtained liquid hydrogen, and the following year at the centenary celebration of the Royal Institution gave a demonstration of his methods.

E. C. S.

Societies and Academies.

LONDON.

Royal Microscopical Society (Liverpool Conference), Mar. 30 and 31.—**C. O. Bannister**: Crystallisation of silver beads and detection of platinum metals by the microscope. In the presence of small quantities of platinum or palladium, the normal crystallisation of silver is displaced by a banded structure. In the presence of iridium, the silver beads are much more spherical in shape and the crystal faces are covered with lines similar to slip bands. With traces of rhodium, a distinct crystallisation of silver results, each face being frequently covered with parallel straight lines quite different from those caused by iridium. With additions of ruthenium, the markings on the crystal faces have a single-sided herring-bone structure.—**Conrad Beck**: The best method of illuminating metallurgical specimens. The most minute structure that has yet been photographed under the microscope with ordinary light is shown in Mr. H. Wrighton's photographs of steel, where the finest lines are about 150,000 to the inch. Mr. Wrighton's method of illumination produces the ultimate theoretical resolution possible; it depends upon the utilisation of the full aperture of the apochromatic object glass in use and limits the beam of light so that although it fills the aperture, it allows no light beyond that forming the image to enter the microscope.—**Ruth C. Bamber (Mrs. Bisbee)**: A simple method of demonstrating the anatomy of trematodes. The details given refer to *Distomum hepaticum*:—(1) Wash well by shaking in normal saline; (2) immerse in fresh water for four to twenty-four hours; (3) place in 3 per cent. glacial acetic acid until differentiation is complete; (4) place in fresh water under a piece of glass heavy enough to compress the animal slightly. Examine with a binocular microscope or a hand-lens, and with reflected and transmitted light. The times vary with the size of the specimens. Differentiation is progressive. When complete, all the systems of the body, except the excretory system, show up by reflected light as though painted in Chinese white on a semi-transparent background. The excretory system is seen very clearly by transmitted light early in the process of differentiation.—**W. E. Cooke** and **C. F. Hill**: Pneumokoniosis due to asbestos dust. Although the asbestos industry is more than two thousand years old, only two cases of lung disease due to asbestos dust appear in medical literature. The present case was unique in two respects. First, the particles found in the lungs were large—some measuring 360 microns in length—and were proved to be the brittle iron-containing part of the asbestos fibre. Chemical analyses of the mineral in the various processes of manufacture and of the dust were compared with the microscopical appearances, and it was proved that the dust contained 18 per cent. of iron as ferrous oxide, the raw material 2·1 per cent., and the finished article 0·1 per cent. The second feature was the presence of a fungoid body. Some deny that it is a fungus, others contend that it is an aspergillus. The authors incline to the view that it is a hyphomycete analogous to that found by Dr. H. H. Scott in batrachians, or that it belongs to the family of hyphomycetes described by Ehrenberg in 1818, the Tuberculariaceæ.—**R. J. Daniel**: Method of staining and cleaning crustacea. Briefly, the method consists in taking small or medium sized crustacea, which have been bleached either by prolonged immersion in alcohol (*e.g.* museum specimens) or by the use of perhydrol (Merck), and leaving them overnight in a 0·05 per cent. solution of parabenzo-quinone in absolute alcohol. The specimens are then passed through various mixtures of absolute alcohol and methyl-salicylate, and finally cleared in the latter liquid. The muscles are stained red and the rest of the animal is transparent.—**I. S. Double**: The microscopic characters of certain horizons of the Upper Chalk. The chalk of the eastern counties of England contains 97-99 per cent. of calcium carbonate. The remainder consists mainly of a clay-like substance with a small proportion, less than 0·01 per cent., of detrital mineral grains. Of these, quartz and felspar occur most frequently, a fair number of the quartz grains with diameters of 0·1 mm. to 0·4 mm. being well rounded. Zircon, rutile, mica, tourmaline, and iron oxides are usually present, but kyanite, andalusite, chlorite, sphene, and staurolite are only occasionally present It is considered that they were wind-blown into the chalk-sea. Very few organic remains are present, the greater part of the chalk consisting of a fine-grained aggregate of calcium carbonate. This is crystalline for it reacts to polarised light.—**R. Ruggles Gates** The meiotic phenomena in pollen development were studied in *Lathræa squamaria* and in *L. clandestina* an introduced French species. The chromatin behaviour shows only minor differences, both species having 21 pairs of chromosomes. The tapetum i peculiar in being constantly binucleate on one side o the loculus and uninucleate on the other. Crystalloid are found in the nucleolus of the pollen mother cel nucleus, and in synizesis the spireme is constantly attached to one or more nucleolar bodies. Th spireme does not form a continuous thread but remains a reticulum, in which the chromosomes ar formed by flowing together of the chromatin at certai points, producing pairs of chromosomes. The tapetum ultimately becomes plasmodial.—**H. E. Hurrell**: Th ecology of the fresh-water polyzoa in East Anglia Polyzoa are more abundant in the Norfolk water than in any other part of the country. This i attributed to the fact that the rivers and broad afford a suitable food supply, namely, diatoms, infusoria, and minute algæ. The rivers Yare, Bure Thurne, Waveney, and their tributaries are all directly connected with Breydon Water, an estuary of th Yare, 3½ miles by ¼ mile, which is a unique cultur bed for the diatoms, algæ, etc. Most of the known British species of fresh-water Polyzoa are found *Victorella pavida* has not yet been discovered, although its usual host (the hydrozoon *Cordylophora lacustris* occurs in the river Thurne in great luxuriance.

(*To be continued.*)

MANCHESTER.

Literary and Philosophical Society, April 5.—**J. Wilfred Jackson**: New Carboniferous lamellibranchs, and notes on other forms. The recent resurvey of the coalfields of Lancashire, Yorkshire, and Cumberland by the Geological Survey of Grea Britain has provided material for a revision of certai Carboniferous marine lamellibranchs. The collections consist largely of shells belonging to the gener Pterinopecten, Posidonomya, and Posidoniella. Thes have been studied in association with material from other sources. Several new species of Pterinopecten all previously ascribed to *P. papyraceus* (Sow.), bu coming from lower horizons than that species, ar described. Three of these species are from the Millstone Grit series, and one is from the horizon of th Lower Bowland Shales. New species of Posidonomy and Posidoniella are also described and figured from the Millstone Grit series.—**S. H. Straw**: Fish remain from the Upper Silurian rocks of Ludlow. Derm studs of Thelodus and fragments of "*Scaphaspis truncatus* are recorded from the Whitcliffe Flags udlow. The significance of these occurrences is iscussed, emphasis being laid on the need for caution the use of fossil fishes in fixing the base of the owntonian in other areas, owing to the possibility their occurrence in greater abundance in pre-owntonian rocks in regions where physical con- tions were more favourable to their existence than the Ludlow district.—**Gerald Andrew**: Petr- raphic notes on specimens in the 'David Forbes' ollection of rocks in the Manchester Museum. (1) Two pecimens from the collection from Leicestershire are escribed. The first is a specimen (collected in 1856) om the dyke running across the Mt. Sorrel quarry. t is a fresh rock with peculiarities which differentiate from the melanocratic igneous rocks of the Midlands. ontaining uniaxial augite, plagioclase—andesine to bradorite. No olivine is seen. Patches of fine- rained material are sporadically scattered through he rocks, with needles of oligoclase in a base which is ometimes glassy and sometimes consists of plates of n alkaline felspar, probably orthoclase. The rock ppears to be a new type of lamprophyre. The second ock is recorded from Whitwick Colliery shaft sinking, nd is a fine-grained porphyritic, felsitic variant of he orthophyre described by E. E. Lowe (1926), with ognate orthophyric zenoliths. The precise situation the shaft section is not recorded.

GENEVA.

Society of Physics and Natural History, Mar. 17.— . **Duparc**: An amphibole of the glaucophane group. The author has proved the presence, round a normal laucophane, of an edging where the n_g and n_m axes re inverted. The plane of the y axes is 90° from that f the normal glaucophane. The name of pseudo- laucophane is given to this variety.—**J. Favre**: The resence of *Clyplina jurassica*, a calcareous siphon lga, in the Portlandian at various points of the outhern Jura. Although proved present, but not reviously determined in the upper Portlandian of he Salèe, this alga has been found again by the uthor in abundance at various points of the southern ura; it may become a characteristic fossil of the xtreme end of the Jurassic.—**Eug. Pittard**: The veight of the skull and of the encephalon of the Boschimans-Hottentots. Measurements made on 139 kulls from the Cape Town Museum have given verages relatively high for a height so small as that f the Boschimans.

ROME.

Royal Academy of the Lincei, Feb. 20.—**P. Vinassa**: The constituents of the earth's crust and the molecular number. The majority of the substances constituting the air and the waters, rocks, and organic matter of the earth's crust have even molecular numbers.—**A. Russo**: The germinative power of the somatic cells of metazoa and metaphytes and recovery of the sexual power of the impure gametogens in *Cryptochilum echini* (Maupas) in relation to the behaviour of the nuclei during the cycle of development.—**S. Baglioni** and **A. Galamini**: Physiological action of alcohol (iii). Action on the albino rat during growth, insufficient nutrition, fasting, and subsequent nutrition. Ingestion of 1·3 gm. to 4·6 gm. of ethyl alcohol per kilogram of body weight per day produces no definite effect, either harmful or favourable, on the growth of the albino rat or on its resistance to complete abstention from food. It seems, however, to favour increase in weight after the cessation of a fast resulting in loss in weight to the extent of 30 per cent. Alcohol also markedly increases the resistance of the rat to an insufficient sub-protein, sub-lipinic, hyper-carbohydrate diet, but diminishes that to a sub-protein, sub-carbohydrate, hyper-lipinic diet.—**A. Luigi Herrera**: New imitations of amœbæ in motion. Modification of the procedure previously employed results in the formation of structures resembling amœbæ which develop pseudopods and imitate the movements of the natural amœbæ.—**M. Crudeli**: The elementary geodetic distance: process of extension of Jacobi's equation to any Riemann variety.—**N. Spampinato**: New contributions to the general theory of Riemann's matrices.—**R. Caccioppoli**: Multilinear functionals.—**A. Weinstein**: A mixed problem for harmonic functions.—**J. Dubourdieu**: Congruencies of curves.—**O. Onicescu**: The asymptotic behaviour and the zeros of a class of entire functions.—**G. Vranceanu**: Geodetic stability. Application to the conservative systems of mechanics.—**M. Pascal**: The curves which appear in the study of the circuito-translatory current.—**U. Barbieri**: Determination of absolute azimuth made at Andrate in August 1926.—**G. Bozza** and **G. Devoto**: Calculation of chemical affinity on the basis of entropy (ii). The expression previously deduced, permitting of the calculation of the free energy of a chemical process on the basis of the heat of reaction at 298° K., the entropies at 298° of the components in the physical states assured in the equilibrium considered, and the specific heats from 298° to the temperature considered, is applied to a number of reactions. In cases where the available data are trustworthy, the results are satisfactory.—**F. P. Mazza** and **G. Dello Jojo**: The rotatory dispersion of certain aspartic esters. It is not certain that, in aqueous or hydrochloric acid solution, aspartic acid has the normal structure, but this is certainly exhibited by the sodium salt and by the dialkyl esters, which are lævo-rotatory. It would therefore appear more rational to indicate by the name *l*-aspartic acid the acid dextro-rotatory in aqueous solution. Dialkyl aspartates show normal optical dispersion, but the mono-alkyl esters present a distinct maximum for the wave-length about 5209 Å.U. In aqueous solutions of the latter compounds, the α-carboxyl group is probably satisfied by the amino group.—**L. Fernandes**: Researches on sulpho-salts.—**A. Pieroni**: Some derivatives of pyridine.—**M. Comel**: The influence of the hydrogen ion concentration on the respiratory exchanges of the tissues. The results of experiments on the respiratory changes occurring in frog's muscle or liver in phosphate and citrate solutions of different hydrogen ion concentration appear to indicate that the fundamental factor in the maintenance of a high respiratory exchange is a hydrogen ion concentration below the isoelectric point.

VIENNA.

Academy of Sciences, Feb. 10.—**E. Rona** and **E. A. W. Schmidt**: Researches on the penetration of polonium into metals. There is no very great penetration, but on lead a surface effect.—**A. Kieslinger**: Second preliminary report on geological and petrographical researches in the southern Kor Alps (Styria).—**A. Kieslinger**: Paramorphosis of disthene after the manner of andalusite.—**A. Puschin** and **D. Barara**: The equilibrium in binary systems containing cresols as one component.—**W. J. Muller**: The current density and potential curves of metals showing passivity, illustrated by the example of iron.—**A. Kailan** and **K. Melkus**: On esterisation in ethylene glycol.—**L. Schmid** and **M. Zentner**: Dehydration experiments with sitosterine.—**R. Gruner, Z. Benes, E. Schubert,** and **M. Arman**: Some triazoles and their derivatives.—**T. Kisser**: Researches on the influence of nutritive salts on the transpiration, water assimilation, relative shoot and root masses and leaf structure (Parts 1 and 2). Experiments with salts of calcium, magnesium, sodium, and potassium on wheat plants show that there are marked contrasts in the effects of calcium and potassium.

Official Publications Received.

British.

Proceedings of the Royal Irish Academy. Vol. 37, Section B, No. 20: The Topographical Features of the Granite-Schist Junction in the Leinster Chain. By Anthony Farrington. Pp. 181-192+1 plate. 1s. Vol. 37, Section B, No. 21: Further Records of Collembola from Spitsbergen. (Results of the Oxford University Expeditions to Spitsbergen, 1923 and 1924.) By Dr. George H. Carpenter. Pp. 193-200. 6d. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.)

Journal of the Royal Microscopical Society. Series 3, Vol 47, Part 1, March. Pp. 14+96. (London.) 10s. net.

British Museum (Natural History). Picture Postcards. Set H4: Mediaeval Natural History, Series No. 1. 5 cards in colour. 1s. Set H5: Mediaeval Natural History, Series No. 2. 5 cards in colour. 1s. Set H6: Mediaeval Natural History, Series No. 3. 5 cards in colour. 1s. Set H7: Mediaeval Natural History, Series No. 4. 5 cards in colour. 1s. Set H8: Mediaeval Natural History, Series No 5. 5 cards in colour. 1s. Set H9: Mediaeval Natural History, Series No. 6. 5 cards in colour. 1s. (London: British Museum (Natural History).)

Queensland Geographical Journal (New Series); including the Proceedings of the Royal Geographical Society of Australasia. 40th and 41st Sessions, 1924-26. Vols. 40-41. Pp. iv+163. (Brisbane: Royal Geographical Society of Australasia.)

Foreign.

Publications of the Astronomical Observatory of the Warsaw University. Vol 3, Part 1: Determination of Latitude by the Method of Equal Altitudes of Different Stars (Pievzow's Method) and the Corresponding Star-Pairs for Northern Latitudes 20°-40° for the Epoch 1930.0. Vol. 1: Northern Latitudes 20°-25°. Part 1. General Statement. By Prof M. Kamienski. Pp. 58. (Warsaw.)

Mitteilungen der Naturforschenden Gesellschaft Bern aus dem Jahre 1926. Pp. xxxvi+308. (Bern: Paul Haupt.)

Annuaire de l'Académie Royale des Sciences, des Lettres et des Beaux-Arts de Belgique, 1927. 93e Année. Pp. 93+178+4 planches. (Bruxelles: Maurice Lamertin.)

Proceedings of the United States National Museum. Vol 69, Art 14: Classification of the Cheilostomatous Bryozoa. By Ferdinand Canu and Ray S. Bassler. (No. 2640.) Pp. 42+1 plate. Vol. 70, Art. 11: New West American Marine Mollusks. By Paul Bartsch. (No. 2660.) Pp. 36+6 plates. Vol. 70, Art. 15: Generic Names applied to Birds during the Years 1916 to 1922 inclusive, with Additions to Waterhouse's "Index Generum Avium." By Charles W. Richmond. (No 2664.) Pp. 44. Vol. 71, Art. 5: A new Parasitic Nematode from an unknown Species of Bat. By Benjamin Schwartz. Pp. 4. (Washington, D.C.: Government Printing Office.)

Catalogues.

Harrap's Reference List of Educational and General Books, including the publications of D. C. Heath and Co. Pp. 94. (London: George G. Harrap and Co., Ltd.)

Analysis of Coal and its By-Products. (Technical Research Series No. 5.) Pp. xvi+136. (London: Baird and Tatlock, Ltd.)

Abbey Mills Papers. Pp. 16. (London: Grosvenor, Chater and Co., Ltd.)

Catalogue of Books on Natural History. (No. 215.) Pp. 98. (Edinburgh: James Thin.)

Union-Castle Continental Holiday Cruises. Pp. 12. Holiday Tours to Madeira or Canary Islands. Pp. 8. (London: The Union-Castle Mail Steamship Co., Ltd.)

Diary of Societies.

SATURDAY, May 21.

Royal Sanitary Institute (at Guildhall, Bath), at 10.30 A.M.—F. P Sissons: Sewage Disposal.

MONDAY, May 23.

Royal Irish Academy, at 4.15.

Royal Geographical Society (at Lowther Lodge), at 5.—Prof. W. H. Hobbs: The University of Michigan Expedition to Greenland in 1926 and Plans for the Continuation of the Work during the Coming Season.

Royal Society of Medicine (Odontology Section) (Annual General Meeting) (at Royal College of Surgeons of England), at 5.30.—Sir Berkeley Moynihan: Address.

Royal Institute of British Architects, at 8.—A. J. Davis: The Moorish Architecture in Northern Africa (Lecture).

Aristotelian Society (at University of London Club), at 8.—Dr. C. Singer: The Mediæval Aristotle.

TUESDAY, May 24.

Zoological Society of London, at 5.30.—Secretary: Report on the Additions to the Society's Menagerie during the Month of April 1927.—H. A. Harris: The Skull Form and Dentition of the Primates.—W. N. F. Woodland: A Revised Classification of the Tetraphyllidean Cestoda, with Descriptions of some Phyllobothriidæ from Plymouth.—Daphne Aubertin: On the Anatomy of the Land Snails (Helicidæ) *Cepæa hortensis* Muller and *Cepæa nemoralis* Linn.

Junior Institution of Engineers (at Showrooms of Holophane, Ltd., Westminster), at 7.—Stage and Colour Lighting (Lecture and Demonstration).

Royal Photographic Society of Great Britain (Scientific and Technical Group), at 7.—H. M. Cartwright and F. J. Tritton: Inherent Fog in Photogravure and a Method for its Elimination.—Dr. F. M. Hamer and O. Bloch: The Optical and Photographic Properties of a Series of Typical Cyanine Dyestuffs.

Royal Anthropological Institute (Conversazione at the Wellcome Historical Medical Museum, 54A Wigmore Street, W.), at 8.30.—Prof. Elliot Smith: The Medical and Magical Aspects of the Anthropological Material in the Museum.

WEDNESDAY, May 25.

Royal Society of Medicine (Comparative Medicine Section) (Annual General Meeting), at 5.—Dr M. J. Rowlands: Rheumatoid Arthritis: Is it a Deficiency Disease?

Geological Society of London, at 5.30.—Dr. F. S. Wallis: The Old Red Sandstone of the Bristol District.—Sir Arthur Smith Woodward on behalf of Prof. Sampat Iyengar: Exhibition and Description of Photographs of a Cretaceous Reptilian Vertebra from Southern India.

British Psychological Society (at Royal Anthropological Institute), at 8.15.—Dr. E. Hamilton Wild: The Influence of Conation on Cognition.—Dr. A. C. Garnett: A Conative Criterion for the Discrimination of Types of Instinctive Behaviour.

THURSDAY, May 26.

Institution of Municipal and County Engineers (East Midland District Meeting) (at Town Hall, Ilkeston), at 10.45 A.M.

British Science Guild (Annual Meeting) (at Royal Society of Arts), at 3.30.

Royal Society, at 4.30.—Helga Pearson: On the Skulls of Early Tertiary Suidæ, together with an Account of the Otic Region in some other Primitive Artiodactyla.—A. W. Greenwood and Dr. F. A. E. Crew: Studies on the Relation of Gonadic Structure to Plumage Characterisation in the Domestic Fowl. II. The Developmental Capon and Poularde.—Dr. F. A. E. Crew: The Laying Hen with Cock's Plumage. Part III.—Dr. E. J. Salisbury: On the Causes and Ecological Significance of Stomatal Frequency, with special reference to the Woodland Flora.—J. W. Trevan: The Error of Determination of Toxicity.—C. K. Drinker and E. D. Churchill: A Graphite Suspension for Intravital Injection of Capillaries.—Dr. F. W. R. Brambell: The Development and Morphology of the Gonads of the Mouse. Part I. The Morphogenesis of the Indifferent Gonad and of the Ovary.—Dr. A. S. Parkes: On the Occurrence of the Œstrous Cycle after X-Ray Sterilisation. III. The Periodicity of Œstrus after Sterilisation of the Adult.

FRIDAY, May 27.

Royal Society of Medicine (Disease in Children Section) (Annual General Meeting), at 5.—Dr. J. D. Rolleston: The Section and its Work, 1908–1926 (Presidential Address).

Physical Society of London (at Imperial College of Science), at 5.—Demonstration: The Production of Splashes by Electric Discharge, by G. L. Addenbrooke.—Communications:—Dr. Ezer Griffiths and E. Griffiths: A Duplex Reversal Key with Mercury Contacts.—L. Hartshorn: The Measurement of the Inductances of Four-terminal Resistance Standards.—Dr. C. Chree: Magnetic Disturbances and Aurora as observed by the Australian Antarctic Expedition at Cape Denison in 1912 and 1913.—K. R. Rao: Series in the Spectrum of Trebly-ionised Tin (Sn. IV).

Royal Society of Medicine (Epidemiology and State Medicine Section) (Annual General Meeting), at 8.—Dr. W. S. C. Copeman: The Prophylaxis of Measles, with a Suggested Scheme for Dealing with Epidemics.

Oxford University Junior Scientific Club, at 8.15.—F. E. Smith: Address.

Royal Institution of Great Britain, at 9.—H.E. the Marquis de Merry Del Val: Gabriel y Galan, Contemporary Spanish Poet (with Quotations in Spanish).

Institution of Municipal and County Engineers (South Wales District Meeting) (at Newport).

SATURDAY, May 28.

North of England Institute of Mining and Mechanical Engineers (at Neville Hall, Newcastle-upon-Tyne), at 3.—W. S. Armstrong: Variable Speed Gears and their Application for Colliery Purposes.

Institution of Municipal and County Engineers (South Wales District Meeting) (at Newport).

PUBLIC LECTURES.

SUNDAY, May 22.

Guildhouse (Eccleston Square, S.W.), at 3.30.—Miss Margaret Murray: Ancient Egypt.

MONDAY, May 23.

University College, at 5.30.—R. Johnson: Lord Lister and the Romance of Surgery (only for the members of University College and Medical School).

THURSDAY, May 26.

University College, at 2.30.—Sir Flinders Petrie: Recent Discoveries in Palestine: The City of Gerar.—At 5.—Prof. H. Maclean: Insulin in the Treatment of Diabetes and Some Other Nutritional Disturbances.

SUNDAY, May 29.

Guildhouse (Eccleston Square, S.W.), at 3.30.—Prof. J. Garstang: Recent Discoveries in Palestine.

CONGRESSES.

May 25 and 26.

French Society of Oto-neuro-ophthalmology (at Strasbourg).

June 6 to 9.

Convention of Canadian Chemists (at Quebec).

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Remaining Possibilities of Water-borne Diseases.

THE greatest public health triumph of the last half-century has been the almost complete conquest over water-borne infections. In Great Britain the chief of these is enteric or typhoid fever; and the reduction of the death-rate from this disease in England and Wales from 332 per million of population in the average experience of 1871–80 to 25 per million in the average experience of 1921–25, shows that this disease is following typhus fever and becoming a disease of rare occurrence in the country. Although reduction of personal infection by better nursing and hospital treatment, the increased protection of foods which, like oysters, are eaten raw, and the help which bacteriology has given in securing prompt diagnosis of enteric disease in 'carriers' as well as in clinical cases of the disease, have all borne an important part in bringing about this remarkable result, the chief factor has been the protection of the public water supplies of Great Britain.

The substitution of supplies controlled by municipalities or by large commercial companies for smaller supplies inadequately protected has formed an important element in securing [redacted] Although when accidental contamina as in the historical Maidstone a epidemics of enteric fever—the unification supplies for large communities may imply spread disease, the standard of precautions has steadily improved, and the communal supply of water by a single authority in each area has been the chief means for protecting the communities concerned by means of safe drinking water.

A very large part of the total drinking water supplied in England is derived from rivers; and its protection necessarily implies serious difficulties. Of the two alternatives, that of keeping the water pure and that of purifying it after contamination so as to render it safe for drinking, the first is obviously preferable; but in most modern communities this is impracticable to the extent which would obviate the need for supplemental purification. In this connexion much interest attaches to the report of a deputation which waited on the Earl of Balfour (on behalf of the Prime Minister) on Feb. 15 last. This deputation represented the British Waterworks Association and the Salmon and Trout Association, and it urged on the Government the need for the creation of a national co-ordinating authority with powers to set up rivers- and watershed boards for all rivers in England and Wales.

This was urged in view of the risks to health of the increasing volume of river pollution, the threat to fish life, and the impairment of the beauty of the country caused by the increasing volume of pollution of our rivers. The facts are not in dispute. There is perhaps ample law to enable pollution of rivers to be controlled; but responsible authorities are inert, or fail to co-operate.

Lord Balfour's reply to the deputation took in part the form of most pertinent queries and showed the difficulties of the problem. Is the proposed central authority to have executive powers, and how are these to be related to those of existing authorities? Leaving administration for science, Lord Balfour pointed out that the essence of the problem consists in the purification of effluents before they are discharged into streams. It is evident that rivers inevitably must act both as sources of water supplies and as recipients both of domestic sewage and industrial waste products. The danger that domestic sewage will cause infectious diseases, and the effect of trade effluents on fish life, form two separate problems, of which the former can be much more easily controlled. As regards trade effluents, there must always be involved a balanced consideration of the expense of [illegible]rification and of the loss implied—to [illegible] æsthetics—in neglecting it.

[illegible]ation should, however, do good. [illegible] has generally shown that purification [illegible]ents is economical to the manufacturer [illegible] beneficial to the public; there is [illegible]y instances adequate knowledge [illegible]ication; and the pressure of public [illegible]ll as the utilisation of existing powers is called for to secure the adoption of measures of purification now feasible.

London is the greatest example in the world of a public water supply derived chiefly from sewage-contaminated rivers, which for many years has been distributed daily to several million people without any serious outbreak of enteric fever or cholera attributable to it. This has occurred during a long series of years, in which chief dependence has been placed on sand filtration of the crude river water, and more recently on additional prolonged storage in large reservoirs; and it is a great tribute to the large London water companies in the later years of their experience, and to their still more efficient single successor, the Metropolitan Water Board, that this gigantic experiment on human beings has been so uniformly free from ill results. Under the guidance of Sir Alexander Houston the last-named Board has steadily increased the use of an additional safeguard, and now about 76 millio gallons of Thames water are chlorinated daily. Since 1916 some 2 millions of people have dail drunk this water after filtration without detectin any difference in its taste. Without entering int detail, it is interesting to note the statement mad by Sir Alexander in the twentieth annual report c the Metropolitan Water Board that, judged b bacteriological quality of the water supplied t London, "it would be safer to drink 1000 flui ounces or fifty pints of some of the stored water than one fluid ounce of the raw river water ante cedent to storage."

The steadily favourable experience of the metro polis has some bearing on a report by Dr. Hancoc just issued by the Ministry of Health on an outbrea of illness at Poplar suspected to be due to loca pollution of the water supply. The illness i question was diarrhœa associated with fever, an between July 11 and 12, 114 cases occurred and probably many more. Foods, including milk were excluded, as the result of investigation o well-known lines, as possible causes of the outbreak and suspicion turned to water as a possible vehicl of infection. The water in the implicated are gave unsatisfactory bacteriological results; an investigation showed that in the special are implicated in the "veritably devastating" loca outbreak there existed a complex arrangement o water pipes, those of the local gas works bein supplied in part from the River Lea, opposite th gas works, which in this locality is heavily polluted It is possible that some of this contaminated wate had by reflux got into the water mains of the distric and thus caused a serious outbreak of illness Actual proof that such inter-communication of pur and contaminated water had occurred could not b obtained; but the cross pipes have been discon nected, and the report has a high value in directin attention to the possible dangers attaching to suc arrangements.

Some interest attaches to the bacteriological sid of the investigation. No dysentery-like bacill were identified and agglutinin tests were negative but, as is pointed out by Dr. W. M. Scott in a supplementary report, a similar experience occurre recently in Hanover. In the Hanover experienc a serious typhoid outbreak followed; fortunatel this was escaped in Poplar.

The report should be studied by health officer and water engineers; and it reminds us once mor that the price of immunity from water infection i uninterrupted vigilance both on the engineerin and the chemical side of public health.

The Mechanism of Gaseous Reactions.

he Kinetics of Chemical Change in Gaseous Systems. By C. N. Hinshelwood. Pp. 204. (Oxford: Clarendon Press; London: Oxford University Press, 1926.) 12*s*. 6*d*. net.

MR. HINSHELWOOD'S book provides an opportunity for the general reader to make mself acquainted with a branch of chemistry hich is developing rapidly at the present time, rt of which the importance may not be appre- ated by those who do not profess and call them- lves physical chemists. These new developments ay be summed up in the term 'activation.'

This conception has been introduced in order to ccount for the slowness of chemical change, and particular for the fact that molecules which are pable of dissociating or of undergoing isomeric ange do not do so all at the same time, and mediately, giving rise to instantaneous reactions. his delay can sometimes be traced to the fact at the action is conditioned by association with me foreign substance, *e.g.* moisture, and that the olecules which wish to undergo change have, as were, to form a queue and take their turn in ceiving the necessary dispensation from the propriate official; but since even the wettest d dirtiest materials do not change instantane- sly, there must be some condition of 'activa- n' within the molecule itself which is a necessary ecedent to chemical change. An exception to is rule is found in ionic double decompositions, ere the ions behave as if they were already tivated, and therefore interact as fast as they n come into contact with one another. It is erefore an attractive proposition to associate activity with a condition analogous to ionisation, d for this view there is considerable justification the case of actions which take place in liquid edia. But in the case of gaseous reactions, at st, it is probably more to the point to think of tivation in terms of energy, and to regard an tivated molecule as one which contains a larger pply of energy than its inactive neighbours, ce, when once this reserve of energy is created, can be drawn upon to overcome whatever stacles may be found to impede the progress of emical change.

Physical chemists claim, however, not only to ow of the existence of this process of activation, t also to be able to give a numerical estimate of e degree of excitement which precedes chemical anges of the most diverse character. The most miliar method is to deduce a value for the heat of activation from the effect of temperature on the velocity of the reaction. The relationship which Arrhenius used for this purpose is expressed by the formula,

$$d \log k/dT = A/RT^2,$$

where A is the 'heat of activation' and k is the velocity coefficient at temperature $T°$ abs. This is almost identical with Van 't Hoff's formula,

$$d \log K/dT = Q/RT^2,$$

whereby the heat of a reversible reaction Q can be deduced from the variation of the equilibrium-constant K with temperature; but whereas Van 't Hoff's formula depends on strict thermodynamical reasoning, and can be tested by direct experiment, Arrhenius's formula is necessarily of a more speculative character, since the hypothetical heats of activation to which it leads cannot be measured by any direct process.

The validity of the formula finds some support, however, in the fact that a very accurate linear relationship is revealed in a large number of cases when log k is plotted against $1/T$. When this relation holds good, as in the decomposition of hydrogen iodide into hydrogen and iod[illegible] thermal decomposition of ammonia in conta[illegible] a tungsten filament, one is tempted to believe that the 'heat of activation' deduced from it may perhaps represent a real physical property. A similar statement can be made in reference to those cases in which this method of plotting gives rise to two straight lines with a rounded intersection. This characteristic is observed in the union of hydrogen and sulphur, which Norrish and Rideal formulate as depending, in the lower ranges of temperature, mainly on an interaction at the surface of liquid sulphur, and, at higher temperatures, mainly on an interaction in the gaseous phase.

The chief interest of Mr. Hinshelwood's book is to be found in his description of a second method for determining the energy of activation. This is limited to gaseous reactions, but has a much stronger theoretical basis than the somewhat speculative relationship of Arrhenius. It depends on calculating, by means of the kinetic theory of gases, the number of collisions which take place in unit time between the molecules of a gas, and then comparing this with the actual number of molecules which undergo chemical change in the same unit of time. This calculation shows that in a number of typical bimolecular reactions only a minute fraction of the total number of collisions is effective in producing chemical change. The next step is to calculate from the probability law what excess of energy the reactive molecules must be supposed to contain in order that it may be possessed only by this minute fraction of the total number of molecules. The excess of energy thus postulated is taken as the heat of activation of the bimolecular reaction.

The data for the decomposition of hydrogen iodide provide a coincidence between the values calculated in this way and those deduced from Arrhenius's formula, which can only be accidental, since it is obviously far more exact than the experimental methods on which it is based. In this case the two values for the energy of activation are 43,900 and 44,000 cal., and the calculated velocity coefficient, $3 \cdot 5 \times 10^{-7}$ at 556° abs., is therefore practically identical with the observed coefficient, $3 \cdot 52 \times 10^{-7}$. A more typical case is that of the union of hydrogen and iodine, where the calculated velocity constant at 700° is 0·14, whilst the experimental value is 0·064. This is claimed as "a very good agreement" in view of the fact that, since the two methods of deducing the energy of activation are entirely independent, the calculated velocity coefficient might very well be 10,000 times larger or smaller than the experi[illegible]al value if the theory now put forward were incorrect.

The method described above is particularly applicable to the study of bimolecular actions, which obviously depend in the first instance upon collisions taking place between appropriate pairs of molecules. In several of these cases it has been established clearly that the majority of the collisions are ineffective and result only in the rebound of unchanged molecules from one another; moreover, a quantitative interpretation of the phenomena can be given by supposing that the effective collisions are those which take place between molecules possessing a high energy content. The general reader may, however, be surprised to learn that when two atoms of bromine meet, the collision is ineffective in 999 cases out of 1000. It is difficult to admit that the two free atoms are insufficiently energised to combine, although this conclusion is not completely excluded; but the quantum theory allows us to suppose that in many cases the fundamental difficulty is to get rid of the energy which the atoms already possess, and it is clear that a molecule from which this energy had not yet been dissipated would be liable to break up again on the slightest provocation.

The study of unimolecular reactions is much more difficult, since, if only a single molecule is really involved in the change, there is at first sight no obvious reason why the change should depen on collisions at all. It is not surprising, therefor that there has been an energetic controver proceeding for several years as to the mechanis of the action. Mr. Hinshelwood defines a un molecular action as one in which the proporti of molecules undergoing change in a given time independent of the pressure. Perrin has assume that this law still holds good at infinite dilutio and that isolated molecules in interstellar spa would have the same average life as in a clos vessel. Since this life depends on the temperatu but by hypothesis is independent of collisions wi other molecules, as well as of the unknown veloci of the molecules in absolute space, Perrin an Lewis have postulated that the chemical chan is due to radiation, and that its velocity is depen ent on the 'radiation-density' in the space whi contains the gas. This hypothesis leads to su wildly impossible conclusions (as, for example, th an aqueous solution of a sugar should be hydr lysed with explosive velocity when exposed to t dazzling light of a tallow candle) that its surviv in any form is a thing to be marvelled at.

In order to avoid these grotesque conclusion Lindemann has recently put forward an alternati theory, in which collisions play an essential pa and give rise to a definite proportion of activat molecules. The velocity of reaction must th fall off at extreme dilution, but calculation h shown, in the particular case of nitrogen peroxi (see below), that even when the pressure reduced to 0·01 mm., the number of collisions still far greater than the minimum number r quired to activate the molecules which under chemical change under these conditions; it therefore impossible to make a direct test of t two alternative views at present. Mr. Hinshelwo has, however, recently described two therm decompositions, taking place at much higher te peratures, in which a 'unimolecular' action retarded on reducing the pressure, in accordan with Lindemann's postulates.

Most of the work on unimolecular actions h been built upon imaginary cases. Thus, wh Perrin and Lewis put forward their explanation these actions, no single case was known whi has survived later criticism, since all the examp that were then cited have been proved to ta place at the surface of the containing vessel a not in the interior of the gas. After much searc ing, the solitary case of the decomposition nitrogen pentoxide

$$N_2O_5 \rightarrow 2NO_2 + O$$

as emerged, as being independent of the area of he surface of the vessel, and of the pressure of he gas down to 0·01 mm.; and Mr. Hinshelwood imself has recently added to this exiguous list he thermal decomposition of acetone

$$(CH_3)_2CO \rightarrow CO + 2CH_3\ (?),$$

nd of the isomeric propionaldehyde; but these re queer reactions which cannot yet be represented by chemical equations, since the nature f the products is unknown, although they are bviously complex.

In all these discussions the eminent president of he Chemical Society stands in the background in he unpleasant rôle of the spectre at the feast, ince, if it be true that chemical change in simple ystems generally (and perhaps always) depends pon the presence of moisture, what are we to think f speculations in which so essential a factor is gnored? The quantities of moisture that are nvolved are now becoming known in certain ases, and they correspond very well with those equired to produce a unimolecular film on the urface of the containing vessels. Norrish has herefore put forward the bold but fascinating ypothesis that, in the particular case of hydrogen nd chlorine, the formation of a water-film on the urface of the vessel is a necessary precedent to he occurrence of chemical change in the interior f the gas. This hypothesis may not be true, but has at least the merit of assigning a plausible ôle to the water in changes in which it plays vital part, as well as to the various agents, uch as ammonia, by which its action may be nhibited. In the cases now under consideraion, it is claimed that "the observed rates of eaction are constant and reproducible, whether he gases have been dried carefully or not," and hat "in no homogeneous reaction which proceeds ith measurable and reproducible velocity has he inhibition by drying been demonstrated" p. 103); but the outside observer, remembering he difficulties that have been experienced in the ast by those who have tried merely to repeat he published work of H. B. Baker, will probably emain unconvinced by statements of this kind, ntil Baker himself has announced that he has ried to arrest these reactions and failed.

Termolecular reactions are almost as rare as enuinely unimolecular reactions, since many of hose which are represented conventionally as an nteraction of three molecules, either proceed in wo successive stages or take place at the surface nstead of in the interior of the interacting gases. Up to the present three such cases have survived criticism, namely:

$$2NO + Cl_2 = 2NOCl,$$
$$2NO + Br_2 = 2NOBr,$$
$$2NO + O_2 = N_2O_4.$$

The most remarkable feature of the last action is that it has a negative temperature coefficient, the interaction at 662° abs. being three times slower than at 273° abs. This is accounted for by the fact that "owing to the increasing molecular speeds there is less and less chance, at great temperatures, that two molecules shall still be within range of each other when a third one approaches. It is to be noted that the velocity of reaction falls off only very slowly, so that the diminishing frequency can account for the retrogression without undue strain" (p. 111).

About one-third of the book is occupied with a description of heterogeneous reactions, but these are less uniquely the province of the author, and it will therefore suffice to say that all the main problems of the effects of adsorption, of molecular orientation, and of the texture of the catalytically active surface are discussed in a clear and satisfactory manner. In conclusion, it should be added that whilst the whole book has a definite mathematical basis, it can be read with profit by those whose ignorance of mathematics, or lack of interest in the details of mathematical processes, compel them to practice the gentle art of skipping. The book has, in fact, been written by a chemist for the benefit of other chemists, and the author's mathematical deductions are treated throughout as a means to an end and not as a final goal.

The Theory of Perception.

An Introduction to the Theory of Perception. By Sir John Herbert Parsons. (The Cambridge Physiological Library.) Pp. viii + 254. (Cambridge: At the University Press, 1927.) 18*s*. net.

THE continuity of race of the present fauna of the earth is due to many different factors. In the case of what we call the higher animals—slow-breeding, exposed to the attack of many sorts of enemies, in some cases subsisting on many forms of prey—accurate choice of reaction in each of a multitude of different circumstances has been, and is, a prime factor in the maintenance of race. Even where the choice of reaction may be limited, as between attack, flight, and no action at all, the determination of choice may be complicated; for the numbers of objects to which the choice is to be applied may be almost infinite.

While the primary reactions (such as those mentioned above) may be classified with comparative simplicity, each individual reaction has to be modified in countless ways in accord with the variety of the object. Such ways may be briefly indicated by the expressions 'mode of attack' and 'direction of flight.' In man, the biological value of team-work has been given effect to by a great development of the mechanism of spoken-speech and heard-speech; and man probably alone of all animals is able to convey to a comrade an accurate description of the objects and changes which he observes in his immediate or distant surroundings. His behaviour, both as an individual and as a member of a team, depends, as do the reactions of other animals, upon the distinguishing of differences in the surrounding environment.

Sir John Herbert Parsons compresses into scarcely 250 pages a wealth of information with regard to the perception of phenomena. To him, as to Lloyd Morgan, the progress of evolution from the more simple to the more complex is accompanied at various points by the 'creation' of new developments. It is a creed of emergent evolution, which he uses as a scientific method. In its light, the property of water is an emergent which could not have been foretold from the properties of the hydrogen and oxygen which combine to form it. There are many levels of emergence, and many sub-levels, within the main line. 'Effective consciousness'—that which enables the animal to guide its actions in the light of previous experience and to exercise choice—is one such emergent.

Consciousness involves a subject and an object. The object is a sensory presentation. The sensory presentation is brought about by stimulation of receptor end-organs, and the conscious subject is aware of this stimulation. The author supposes that the simplest form of consciousness is a mere sentiency—an awareness tinged with affective tone, with a minimum of cognition, and possessing a primitive meaning, and that the subject responds with an appropriate motor reaction—"consciousness on the reflex plane." By further differentiation and integration 'awareness' leads to 'interest'; 'affective tone' emerges in 'emotion'—"consciousness on the plane of instinct." Yet further differentiations and integrations by means of memory and association give the emergence of higher ideation and conceptual consciousness—"consciousness on the plane of intelligence." At every level the object of a sensory presentation has to pass through the entry enforced by the receptor organ, and differentiation of receptors—and of the whole receptor mechanism—plays a chief part in analysing the properties of the object. A consideration of data from many sources—general morphology, animal psychology morphology of the peripheral and central nervous systems, the physiology of reflex phenomena, and observation in man—leads the author to maintain the following thesis:

Primitive sentiency is essentially tactile. At higher levels response to radiations emerges and specific receptor organs of many varieties evolve Parallel with this evolution there is an evolution in the complexity of the central nervous system—with the development and dominance of the segments at the anterior end of the axially arranged animal, and the elaboration there of central ganglia for the distance receptors so clearly emphasised by Sir Charles Sherrington. An evolution in perception and in consciousness parallels these morphological evolutions. On the physiological side, reflex action emerges from less differentiated response; and it is inferred that the afferent impulse arouses a vague sentience analysable into two parts—into the germ of affective state and into the germ of cognitive state. The instinctive plane is an emergent from the reflex plane. There is a concomitant complexity of conscious experience, an integration without complete synthesis Before the instinctive act occurs there is an unfocussed affective state—'coenæsthesis'—which acts as a background, and is derived from all the receptors then in activity. Upon this background emotion impinges "like a splash of vivid colour." The more discriminative reactions of the higher vertebrates are emergent from this instinctive level

In consonance with Sir Charles Sherrington's use of the term 'receptor,' the author suggests 'reception' and 'recept' for the act of sensing and the object sensed. Perception consists for him in the integration of recepts. Differentiation, segregation, and integration result in the emergence of a perception, which is not a mere summation of sensations. The latter "have been integrated into patterns, in which the whole is greater than the sum of its parts; something new has emerged in consciousness." The recept is more differentiated the higher we go in the scale of evolution and concomitantly with the differentiation of receptors. At the primitive level it is dyscritic—having little differentiation and little discrimination The constellation of recepts there merely gives a change in potential in the primitive stream of consciousness. The affective tone becomes more pleasant or more unpleasant, and the motor response is correspondingly a mass reaction. In a higher level of evolution, the epicritic stage, differentiation of recepts is made possible by differentiation of receptor mechanisms. The recepts form a perceptual pattern of such a differentiation that the diverse sensations are discriminated. Awareness is focussed upon the features of the pattern and becomes attention. At still higher levels, the syncritic stage, epicritic phenomena are integrated by the cortex cerebri; attention becomes interest and 'meaning' emerges in the perceptual pattern. The primitive dyscritic mass reaction becomes correspondingly differentiated. The perceptual pattern, at first "a buzzing, blooming confusion" accompanied by an awareness, becomes differentiated as the scale is ascended; its higher development is due to a double process—on one hand of differentiation and reintegration, on the other hand of sensitisation from higher levels which have evolved contemporaneously. In the higher stages the perceptual pattern comes more under the control of higher nervous centres. One or other modality of sensation becomes prepotent, the prepotent modalities being those of the distance receptors—smell, sight, hearing. But throughout there persists a dual mechanism in sensation, the dyscritic and the epicritic both persisting.

Such a brief account of the author's 'background' can give no indication of the wealth of vivid evidence from many fields which it serves, or of the facility of his presentation. Excellent and valuable accounts are given of the comparative anatomy of the central nervous system, of cutaneous sensation, of the dyscritic motor response, posture and attitude, of perception of space and of perception of movement. But the book will be valued not least for the author's description, in the chapters on vision, of the distance receptor which he has made his own more particular field; for, as Sir Herbert Parsons says, vision is the preponderant modality in man, and has undergone in him the greatest differentiation. T. GRAHAM BROWN.

Siberian Bronze Age Cultures.

Bronzezeit am Jenissei: ein Beitrag zur Urgeschichte Sibiriens. Von Gero v. Merhart. Pp. 190 + 12 Tafeln. (Wien: Anton Schroll und Co., 1926.) 12*s*.

A BRIEF but very interesting account of the Bronze Age cultures of the Minussinsk area, and a review of the literature on the subject, is given in the work under notice; the author has also some rather revolutionary ideas to put forward. The region is one of peculiar interest, lying as it does far up the Yenisei valley and forming an island of steppe country cut off on three sides from intercourse with the rest of the prehistoric world, for to the south lie mountains and to the east and west were formerly forest lands. To the north, however, lay a natural east-west passage-way formed by the more or less connecting river systems of the Obi, Ket and Angara leading to Lake Baikal. The author stresses the contention that the early Bronze cultures of the district owe nothing directly to the west, *i.e.* to the Bronze cultures of the Ural mountains, though both may originally have had a common source. He believes that it was not until very late that any western connexion was established, and that similarities in the two cultures can then be explained by a parallel reception of Scythian influences.

To the reader it is not quite clear from exactly where the author would like to derive the people whose industries he is describing. South, east, and west being blocked, as already described, they must have arrived as a back-wash from the north, following the Yenisei southwards, but where they originally came from seems uncertain. Having settled, however, in this blind-alley district, it would appear that a slow development took place which was at first little influenced from outside owing to the peculiar geographical position of the area. A very late chronology is adopted; in fact round about 600 B.C. is given as a mean date for the full Bronze culture here.

The chapters devoted to a description of the finds themselves are very interesting, and the illustrations quite adequate. An earlier and a later type of grave (called respectively 'corner stone' and 'collective' graves) are described, from which it would appear that an outside influence must have penetrated the region, but not a new race, as many of the old characteristics continue in the new graves. Finds unconnected with burials are also discussed. Of these the Krasnojarsk celt is the most important, and its distribution problems are very complex. Several chapters are devoted to typological study and decoration motifs.

The only regret one has when putting this book down is that the author has kept so rigidly to the period under review. One would like to have known what he thinks existed before the first culture with which he is concerned. Again, there are rock engravings not so far off from his region, some of which are probably of late date, but others may be very early indeed. A brief mention of them would have been welcome.

The book is very interesting, deals with a little-known but important area, and the author is to be congratulated upon having tackled his subject in a systematic and scientific manner.

M. C. BURKITT.

Our Bookshelf.

The Whitworth Book. Prepared by the Whitworth Society (an Association of Whitworth Scholars, Exhibitioners, and Prizemen). Honorary Editor, Prof. David Allan Low. Pp. vii + 316. (London: Longmans, Green and Co., Ltd., 1926.) 10*s.* 6*d.* net.

THE career of Sir Joseph Whitworth, one of the greatest engineers of his time, is especially interesting, since he was the first man to grapple successfully with the problem of obtaining precision of workmanship and the standardisation of screw threads.

It is difficult to realise now that, when he began work rather more than one hundred years ago, it was exceptional to find men able to make parts of machines to an accuracy of one thirty-second of an inch. His epoch-making discovery of a method of making a true plane by a process of scraping and comparing three plates together made it at once possible for engineers to produce work of the utmost precision. This was followed by the manufacture of very accurate screws and the construction of workshop machines to measure lengths to one ten-thousandth of an inch. Indeed, Whitworth was successful in constructing a machine capable of detecting a difference of one millionth of an inch. His surface plates, gauges, and measuring machines soon became established in all engineering workshops and revolutionised their practice, while his machine tools were admittedly unsurpassed.

Although others had attempted the standardisation of screw threads, no one had been able to effect this until Whitworth took the matter in hand and, by adopting the best features of existing systems, brought about an agreement which has received world-wide recognition. In his later years Whitworth was equally successful in improving the manufacture of rifles, large calibre guns, and fluid-compressed steel.

Whitworth's practical mind also realised the necessity to the engineering industry of a continuous supply of young engineers who, in addition to workshop experience, were thoroughly conversant with applied science. Having acquired a large fortune in his manufacturing career, he was able to put his ideas into practice by setting aside £3000 a year for scholarships, and at his death £100,000 was handed over to the State to carry on the scheme associated with his name.

The Whitworth Book is the "Who's Who" of about one thousand Whitworth Scholars appointed under this munificent scheme. Its pages show how vast an effect this scheme has had on modern engineering in every direction of activity. Probably no engineering work of this great man has been more successful than this final one. The Whitworth Society, and especially the honorary editor, are to be congratulated on having produced a very interesting work of permanent value.

E. G. C.

History of the Sciences in Greco-Roman Antiquity. By Prof. Arnold Reymond. Translated by Ruth Gheury de Bray. Pp. x + 245. (London: Methuen and Co., Ltd., 1927.) 7*s.* 6*d.* net.

PROF. REYMOND begins his volume—the outcome of lectures before both science and arts students at Neuchâtel—by outlining the scientific attainments of the Egyptians and Chaldeans prior to the epoch with which he is mainly concerned. He divides the rest of the book into two parts.

Part I. gives a historical and biographical survey of the development of the sciences during the Hellenic (650–300 B.C.), Alexandrian (300 B.C.–A.D. 100), and Roman (A.D. 100–600) periods. Part II. deals with the principles and methods, and traces the development and characteristics of Greek mathematics and mechanics. The works of Euclid and Archimedes are ably discussed, especially from the point of view of their indebtedness to predecessors.

Whilst these sciences were well developed, others remained almost neglected. Chemical knowledge was practically confined to the preparation of a few salts, extraction of minerals, mixing of paints and concocting drugs. Medicine and surgery were, however, systematically practised and reached a high degree of perfection, as indicated by the comprehensive set of instruments discovered at Pompeii. Aristotle had established a scientific basis for natural history, introducing a classification founded largely on his own observations. His pupil, Theophrastus, catalogued more than 500 plants.

It may be noted how Greek science, first centred at Athens, finally flourished on the periphery of the Hellenic world, especially under the Ptolemies at Alexandria.

Prof. Reymond has dealt with every phase of the teachings of the different schools of the sciences in Greco-Roman antiquity, and students of the history of science will be grateful for this translation of his work.

J. G. F. DRUCE.

Citrus Growing in South Africa. By R. A. Davis. Pp. 309. (Cape Town and Johannesburg: The Specialty Press of South Africa, Ltd.; London: L. Reeve and Co., Ltd.) 25*s.* net.

THIS work begins with a brief foreword by the author, in the course of which he suggests that the time appears to be favourable for the publication of such information as the book contains, because, he avers, "Citrus and, especially, Orange growing is 'booming,' and there are many thousands of new-comers to South Africa who are bent on Citrus culture as a means of livelihood." The introduction of citrus fruits into South Africa is dealt with in Chap. i. It seems somewhat indefinite as to when they were first introduced; but oranges, lemons, and citrons are known to have existed so early as 1662, in the garden of the founder (Van Riebeek) of the first Dutch Colony, Cape of Good Hope, in 1652. The 'bitter Seville orange' and the ordinary 'rough lemon' have run wild in parts; both are used for stocks for grafting purposes, the 'rough lemon' (called 'Mazoe lemon'—the banks of the Mazoe River being in places lined with the trees) is described in Chap. v. on "Stocks for the Orange" as being the most widely used stock in South Africa.

As an industry, citrus cultivation, from comparatively small beginnings, dates from about 1907, until at the present time the productive area in the Union is estimated to cover about 25,000 acres, the exports including grape-fruit, *naartjes* (mandarin and tangerine oranges), and lemons.

Throughout the course of the whole twenty-six chapters the author has given a very complete record of the progress of production, based on scientific principles in developing the best varieties, the best methods of grading and packing of the fruit for export, and advice in the treatment of fungus diseases and insect pests. J. H. H.

Byways of the Tropic Seas: Wanderings among the Solomons and in the Malay Archipelago. By Hermann Norden. Pp. 250 + 30 plates. (London: H. F. and G. Witherby, 1926.) 16*s*. net.

Mr. Herman Norden, already well known as the author of several books of travel, here records his impressions of a voyage to the Solomon Islands and thence to the island of Bali, that fascinating dependency of Java. Of the Solomon Islands he has nothing to say that is of moment to either the geographer or the anthropologist. His story depends for its interest upon his lively sketches of the sailors, traders, and natives whom he met. He gives a vivid enough picture of their life and the experiences which are likely to befall any one who makes a voyage among the islands in a small trading vessel. His account of Bali and its people, though somewhat superficial and new only in an impressionistic sense rather than as a record of fact, covers ground less known than the Solomons and will repay perusal by those who have neither the time nor the opportunity to read more serious treatises on the very distinctive culture of the island.

Mr. Norden was fortunate enough to see some of the principal ceremonials in the life of the Balinese, and describes the rites of their peculiarly modified form of Buddhism, including the *mudras*—the ceremonial gestures which have been carefully described in detail in a graphic style by Miss de Kleen—their cremations, their dances, their shadow puppet plays, and other features of their culture. Unfortunately, on the occasions when Mr. Norden ventures outside what he has actually seen, his statements are seldom free from error in anthropological matters. It surprises to find Polynesian and Melanesian alike described as "Aryan."

The Bryant and May Museum of Fire-Making Appliances: Catalogue of the Exhibits. Compiled, with an Introduction and Notes, by Miller Christy. Pp. viii + 192 + 33 plates. (London: Bryant and May, Ltd.; Simpkin, Marshall and Co., Ltd., 1926.) 5*s*. net.

An addition of a novel character to the museums of Great Britain has been made recently in the form of one devoted entirely to fire-making appliances. Fire making is of vital human interest, and here we see the many methods that have been used in past ages and in different climes. Messrs. Bryant and May's collection at their Fairfield Works, Bow, in the main is that formed by Mr. Edward Bidwell during a period of half a century. Perhaps this should have become a national possession, but within the last year it passed into the keeping of the firm, who have housed it admirably. Considerable additions have been made, and it includes every known method of fire making. It is, indeed, so comprehensive that it is difficult to conceive that it can ever be rivalled. The objects are classified under tinder; wood-friction methods; flint-and-pyrites methods; flint-and-steel methods; quartzite-and-iron methods; optical methods; compression methods; chemical methods; and finally the friction match. Of the exhibits, about half represent the flint-and-steel and friction-match methods. The museum is not open to the public indiscriminately, but is accessible to the student, societies, etc., without charge, during week-day afternoons or Saturday mornings, on application to the firm.

A Laboratory Book of Elementary Organic Chemistry. By Prof. A. Lowy and W. E. Baldwin. Pp. ix + 182. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1926.) 15*s*. net.

There are several novel features about this laboratory manual. Two illustrations form the frontispiece, of which one depicts an alchemist at work, the other a research laboratory at the Mellon Institute, Pittsburg. Instructions to the student are freely illustrated, not only by line-drawings or pictures of apparatus, but also by sketches of industrial plant. The latter are most effective, helping as they do to correlate laboratory experiments with actual practice. The course of work is that adopted at the University of Pittsburg, and an essential part of the scheme consists in writing out a report on each experiment in the form of answers to questions upon perforated sheets, which can be detached when completed and handed to the demonstrator. Afterwards they can be gummed into place again, so that the student may eventually possess a well-illustrated and bound record of his work. Directions are given for the preparation and investigation of a number of fairly simple organic substances, but in the section on carbohydrates, prominence is given to the investigation of cellulose and to the preparation of viscose. Two pages are devoted to the application of dyestuffs, and a few of the more important reactions of heterocyclic compounds and of alkaloids are appended.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Bands in the Absorption Spectrum of Mercury.

IN a paper just published in the Royal Society's *Proceedings* for May, it is shown that excited mercury vapour from a low-current discharge gives, in addition to the better-known feature of the mercury band spectrum, a series of bands which were observed from λ3055 to λ2697. I find that these bands converge to a point very near the resonance line 2537.

I have now obtained bands of the same system in absorption by a long column of the vapour of boiling mercury, which shows that they involve transitions to or from the unexcited electronic state. These bands are allied to, but not identical with, the emission bands, and converge towards a point in the spectrum somewhat more refrangible than the resonance line λ2537. I have obtained about fifty of them. They are seen to best advantage on the border of the region of intense absorption which starts from the resonance line and extends towards the red. As the density of mercury vapour is increased, the region of intense absorption extends farther towards the red, and a part of the band system mentioned is blotted out by the intense general absorption. At the same time the increased quantity of mercury allows them to be traced farther towards the red, and the distinctness is improved. This is very like the behaviour of ozone in the absorption at the limit of the solar spectrum, and also in laboratory experiments, as traced in 1917 by Prof. Fowler and myself.

The mercury bands have not yet been satisfactorily analysed for classification by the quantum theory. There are certain suggestive differences in detail between the emission and the absorption bands. The spacing of these bands is of the order of 10 Ångströms.

In addition to this new system in the absorption spectrum of mercury, it is already known that there are diffuse absorption bands at λλ2345, 2338, 2334 and 2339, thus with a spacing of the order of 5 Ångstroms. Closer examination of these has now shown that superposed upon this structure there is a much finer one, of the order of 1 Ångström. This occurs in and between the conspicuous bands named, and extends beyond them as far as λ2300 and possibly farther. The spacing becomes closer, and with the instrument at present available I have not been able to resolve the structure any further. In the paper cited I have shown the intimate connexion in *emission* between this part of the band spectrum and the 'forbidden' line λ2270. Neither this nor the other forbidden line at λ2656 can be detected in absorption.

The mercury absorption spectrum has often been examined before by experienced observers, and it may cause surprise that the features above described have not been noticed. It is due, I think, partly to insufficient length and density of mercury vapour, and partly to the use of an unsuitable bright source for observing the absorption. Bright lines in the source are very baffling.

It is hoped to examine exhaustively these and the remaining portions of the mercury band spectrum with adequate resolving power.

RAYLEIGH.

69 Cadogan Square, S.W.1,
May 16.

Modified Scattered X-Radiation due to Super-Position.

MAY I place on record what is, I think, the most direct evidence that the modified scattered radiation is due to the super-position of unmodified scattered radiations? When using a certain primary X-radiation, the scattered radiation from air was found to be totally unmodified radiation, *i.e.* a radiation with accurately the same absorbability as the primary radiation exciting it. The radiation scattered from paper or paraffin-wax was very definitely a modified scattered radiation, or contained a modified radiation, *i.e.* differed considerably in absorbability from the primary radiation. Also these two radiations scattered from paper and from paraffin-wax were equally modified—within a small possible error.

Such results have frequently been obtained in this laboratory. As previously recorded, we have even obtained modified scattered radiation from thick sheets of scattering material, when the radiation from thin sheets was an unmodified radiation as tested by absorption measurements.

In our recent experiments, however, we made a systematic examination of the radiation scattered from various thicknesses of scattering substance. It was found that with a certain primary radiation, when the sheet of paper or paraffin-wax was made gradually thinner, the difference between the primary and scattered radiations became smaller, and ultimately almost vanished, indicating very definitely a vanishing difference for an infinitely thin layer of scattering material.

The possibility of this effect being due in some way to a mere variation of the intensity of ionisation is quite ruled out of consideration by the facts that:

(1) A large variation of output of the Coolidge tube was entirely without influence on the measured difference between primary and secondary radiations, and that

(2) Equal degrees of modification of the rays scattered from paper and from paraffin-wax were produced by scattered radiations of quite different intensity. Thus the slab of paraffin-wax used as scattering substance had to be seven or eight times as massive as the slab of paper in order to produce an equal degree of modification in the scattered radiation as measured by absorbability. Under such corresponding conditions, the intensity of the scattered radiation from paraffin was, roughly, seven times the intensity from the paper.

Plotting the change of absorbability on scattering against mass per unit area of the scattering sheet, we obtained curves of form precisely like the familiar ionisation-pressure curves showing saturation current. In our experiments what was shown was a saturation amount of modification by scattering from thicker layers of scattering material. The maximum amount of modification was shown much earlier for a paper than for a paraffin-wax scatterer, but the two measures of modification were finally equal. Other experiments on this phenomenon—for it of course raises many questions—will be described elsewhere.

It should, however, be added that all X-radiations are not equally sensitive to a change in the amount of scattering substance. The scattering radiation was evidently near the critical condition for a change of its level of activity such as we have described in papers on the *J*-phenomenon. It afterwards settled down to a state in which thick sheets, thin sheets, and even air itself all produced a scattered radiation showing the full amount of modification such as had previously only been given by thick sheets. It is, of course, possible—indeed I think probable—that it was then necessary only to experiment upon much thinner layers still, in order to obtain the vanishing amount of modification by scattering. This, however, was beyond the range of experiment.

What we have shown is that by experimenting on a suitable radiation, a perfectly regular development of the modified scattered radiation can be traced to the superposition of unmodified radiation from thin layers. This further illustrates what we have previously described as the coherence of superposed X-radiations. Neither quanta nor wave-trains within narrow limits of wave-length can be considered independent in their action; it is the whole stream of radiation which is effective.

C. G. BARKLA.

University of Edinburgh.

Philosophical Foundations of Quantum Theory.

IN his very lucid and interesting article (this is no empty compliment) in NATURE of April 16, Dr. Jordan makes two misstatements. On p. 569 he says that in C. T. R. Wilson's experiments the time of a single quantum jump is a measurable quantity. But those experiments involve no time measurements at all. Time enters only through the velocity of the particles; and if inquiry is made how it enters into the value assigned to this velocity, it will be found that the time measurements concerned are made on large aggregates of atoms and have nothing directly to do with quantum jumps. Again, he says that the experiments of Geiger and Bothe and of Compton prove that the interval between emission and absorption is exactly that of the light path between the atoms concerned. But all that these experiments proved was that the interval was less than 10^{-3} sec.; the interval of the light path was about 10^{-9} sec.

Of course Dr. Jordan knew that these statements were not wholly accurate; a limit to accuracy is always set by brevity, and he would doubtless reply that the inaccuracy does not affect his argument. But if there is anything in certain vague ideas which I have twice tried to present to physicists (NATURE, 107, 170; 1921; *Phil. Mag.*, 1, 1106; 1926), it does affect his argument very greatly. I must apologise if I am too pertinacious, but every serious writer on the difficulties of quantum theory gives me the same excuse as Dr. Jordan. They all develop their argument up to a point where (as it seems to me) they are bound to notice my suggestion, if only to reject it; they then make some statement about time that is patently false, and, without noticing it, proceed on some different line of thought. If only somebody would explain why the suggestion is too silly to be worth discussing, there would be an end of it, once and for all.

Briefly, the suggestion is that time is a statistical conception, significant only with regard to large aggregates of atoms; and that it is as meaningless to speak of the time interval between atomic events as of the temperature of an isolated molecule. If that suggestion is right, some of Dr. Jordan's questions are answered or become unanswerable. He asks: Will it ever happen that the time of a quantum jump is undetermined? Certainly, for there is no such time.

The conception of a statistical time is, of course, not easy. But the general nature of the influence which it would have on our ideas can be grasped by means of an analogy. If all 'regular' clocks were abolished from our laboratories, and we were forced to use radium clocks, in which the defining events are the disintegration of individual atoms, it would be very difficult to demonstrate some of the experiments on which our conceptions of 'continuous processes' and 'causal relations' are based. That difficulty, I think, is precisely the difficulty which we encounter when we proceed from the world of atomic aggregates to that of individual atoms.

NORMAN R. CAMPBELL.

I SHOULD like, first of all, to express my regret that up to now Dr. Campbell's most interesting papers have escaped my notice. The expressions which I used, and to which Dr. Campbell takes exception, would certainly have been more precise had I taken account of Dr. Campbell's work.

As for Dr. Campbell's idea, I should like in the first place to point out that the matter has been considerably advanced by two papers by Dr. Dirac (P. A. M. Dirac, *Proc. Roy. Soc.*, London) and by me (P. Jordan, *Z. für Phys.*, 40, 809; 1927) on the foundations of quantum mechanics, and by Dr. Heisenberg's "Über den anschaulichen Inhalt der Quantenmechanik," which is based upon them (W. Heisenberg, *Z. für Phys.*, in press). These investigations corroborate Dr. Campbell's opinion in certain respects; on the other hand, they indicate certain limitations. Heisenberg has explained how the Cartesian coordinates, *e.g.* of an electron in hydrogen atoms, can be regarded as exactly measurable; and correspondingly one must consider the 'fourth co-ordinate' $q_4 = ict$ as exactly definable and measurable. The difficulties of a measurement of t which are brought out by Dr. Campbell arise in the measurement of every physical quantity in an atom (*e.g.* energy). How and to what extent these difficulties can be overcome has been considered in detail by Heisenberg. In this respect, therefore, the quantum mechanical conceptions differ from those of Dr. Campbell.

In a certain respect Dr. Campbell's views are, however, confirmed by the quantum mechanics: for if the atom has specified quantum numbers, the time (and the co-ordinates) are statistically, and only statistically, defined. For the characteristic feature of the quantum mechanics is that one cannot specify simultaneously all of the $2f$ constants of integration of the classical dynamised system, and, in particular, that one cannot specify both a co-ordinate and its conjugate momentum. Similarly, one may specify the energies of the initial and final states of a quantum jump; then the time of the jump is indeterminate. But one can equally well specify the time of the jump, and leave unspecified the initial and final states; and within certain limits of accuracy one can specify both the initial and final states and the time.

Undoubtedly this discussion is too short and too inaccurate to elucidate the point completely. I should like, therefore, to refer Dr. Campbell again to Heisenberg's paper, in which these questions are treated in detail.

P. JORDAN.

The Law of Flame Speeds.

IN NATURE of Dec. 11, 1926, p. 837, Prof. W. A. Bone stated that he would at some future date publish the results of experiments on the 'uniform movement' of flame which disproved the law of speeds. The work referred to has now been published in the *Proceedings of the Royal Society* (A, 114, 420; 1927) and we can reply to Prof. Bone's letter. The principal mixtures he has chosen to test the law of speeds are of ethylene and acetylene with oxygen, and the choice is made because, to use Prof. Bone's own expression, these mixtures are so 'sensitive' (*i.e.* highly responsive to accidental changes in experimental conditions).

We have for some time been engaged in further study of the law of speeds with the view of ascertaining its meaning. We have not hitherto, in our experiments on the uniform movement, used mixtures of combustible gases with oxygen, nor have we used acetylene, the very 'sensitiveness' of such mixtures being the reason for our not using them as means of elucidating the law. We have now, however, put in hand experiments with mixtures containing ethylene and acetylene with oxygen, and will publish the results.

Prof. Bone has also used mixtures of methane and hydrogen with air, the inflammable gases being in excess. We have directed attention in our papers in the *Journal of the Chemical Society* to the fact that divergencies from the law of speeds are to be expected, and have been found, with these gases when the oxygen is in deficit. This is admitted on p. 421 of Prof. Bone's paper, but overlooked on p. 438, when the methane-hydrogen experiments are discussed and divergencies from the law are emphasised. Thus it is true that the equimolecular mixture of methane and hydrogen with air in which the speed of uniform movement of flame is 80 cm. per sec. (combustible gases in excess) is not obtained with the calculated (blended) mixtures of methane-air and hydrogen-air having that speed of flame, but with a mixture containing slightly more air. Owing to the steepness of the speed-composition curves towards the limits of inflammability, a small difference in the composition scale is magnified considerably on the speed curve. We reproduce, in illustration of this, a set of speed-composition curves embodying the results of series of determinations with mixtures with air of hydrogen, methane, and equimolecular mixtures of these two gases (Fig. 1), from which the full extent and the general nature of the divergencies from the law can be judged. The two mixtures chosen by Prof. Bone to test the law contained 11·05 per cent. methane in air and 71·9 per cent. hydrogen in air. The result obtained with a blend of these two mixtures such as would give an equimolecular mixture of methane and hydrogen would fall near point A on our diagram.

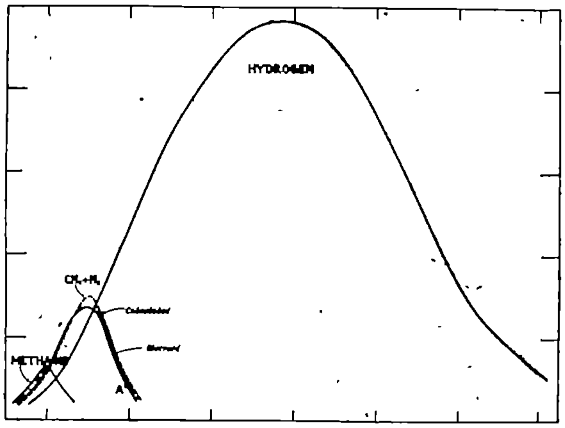

FIG. 1.

Other examples of the application of the law to the uniform movement of flame, showing the extent of the divergencies, will be found in the *Journal of the Chemical Society* (115, 1454, 1919; 117, 48, 1920). We have recently (*Journal of the Chemical Society*, February 1927) dealt with the application of the law of speeds to a condition of flame propagation other than the 'uniform movement,' namely, propagation within a closed sphere, using mixtures of hydrogen and carbon monoxide with air. The results were in accordance with the law.

W. PAYMAN.
R. V. WHEELER.

Safety in Mines Research Board Laboratories,
Sheffield, April 26.

The Spectrohelioscope and Direct Telescopic View of Solar Prominences.

IT is rather hesitatingly I venture to discuss one or two remarks by Prof. Hale in his interesting contribution entitled "The Fields of Force in the Atmosphere of the Sun," in NATURE of May 14, p. 708. The instances in which I have observed, with perfect ease, intensely black (and bright) hydrogen flocculi, often of stupendous magnitude, suddenly develop near active spots, and even where no conspicuous spots were visible at all at the moment, can be counted by the hundred in my observational notes. I have frequently taken occasion to describe such observations in scientific journals, as well as alluded to them in my annual report to the *Monthly Notices of the Royal Astronomical Society*, which circumstance I wish to mention particularly, because Prof. Hale seems to attribute this kind of observations exclusively to the capabilities of the spectrohelioscope, whereas a good solar grating spectroscope has shown me practically all the phenomena he describes, on many occasions. Had I at my station the superior apparatus of Mt. Wilson, or Pasadena, at disposal, and above all the incomparably more numerous and favourable observing opportunities afforded by Californian skies, I should of course be able not only vastly to increase the number of my observations, but also to enjoy better access to the finer detail only seen here when the air conditions are best.

I have also pointed out the drawback of the second slit of the spectroheliograph, which obscures deflexion effects beyond the amount permitted by the width of the second slit, such effects showing perfectly satisfactory with the single slit solar spectroscope. If enhanced seeing is desired, the introduction of a second adjustable, and laterally movable, slit in the focal plane of the ocular of the view-telescope helps to exclude unwanted light from the field of view. Of course, if the second slit is set too narrow, the same difficulty just mentioned in connexion with the second slit of the spectroheliograph is introduced, wherefore in the case of displacement observations, the second slit in the ocular is opened out to the maximum amount of displacement seen through the first slit. Good vision of such evolutions is further enhanced by the use of an eye-cup attached to the ocular of the view telescope.

In spite of the many observations (also shared by myself), which have caused other writers to state that the dark flocculus was sucked through the spot cavity into the interior of the sun, this contention cannot be correct for purely physical and mechanical reasons attending spot evolution. The flocculus may be seen drawn towards the spot vortex, from above and from aside the latter, but on nearing the general upper levels of the spot-umbra, this indrawing action becomes arrested and the gases of the flocculus start to partake of the radial outflow of the gases coming up the spot-cavity from the interior. Where the flocculus encounters these, it becomes heated up temporarily into brightness before being scattered sideways into the penumbral regions.

On May 7, 1927, at 1.45 Greenwich Summer Time, I had the good fortune to witness an exceptionally brilliant eruptive prominence shoot out near Position Angle 85°. The display was for a few minutes of such intensity that the whole length of the spectrum showed indication of being traversed by a ribbon of continuous light. Leaving the slit tangential to the same Position Angle, but using the direct reflecting position of the grating, I had no difficulty in discerning the clear-cut, pale-white form of this prominence. Its brilliance in the first order of the spectrum induced a reasonable expectation of this direct view, and I feel positive that such a prominence would be readily visible at sunrise, or sunset, with the sun's limb just registering with the horizon.

Albert Alfred Buss.

Chorlton-cum-Hardy,
Manchester,
May 16.

White Spot with Newton's Moving-Water Rings.

Layers of moisture, grease, etc., condensed on solid surfaces play an important part in many phenomena, hence it may be of interest to recall an observation made by Newton, which, so far as I know, is never referred to in modern text-books. Observation XI. in "The Second Book of Opticks," Part I. (1704), is one of Newton's many careful observations of the coloured rings seen between convex and plane surfaces of glass, and is as follows: "When the water was between the Glasses, if I pressed the upper Glass variously at its edges to make the Rings move nimbly from one place to another, a little white Spot would immediately follow the centre of them, which upon creeping in of the ambient water into that place would presently vanish. Its appearance was such as interjacent Air would have caused, and it exhibited the same Colours. But it was not Air, for where any bubbles of Air were in the water they would not vanish. The reflexion must have rather been caused by a subtiler medium, which could recede through the Glasses at the creeping in of the water."

I have taken rough 'snapshots' of this phenomenon, two of which are here reproduced (Fig. 1), but owing to photographic exposure difficulty they do not show the brilliant coloured rings which extend across the white spot. Fig. 1*a* shows the formation of the white spot sharply at the edge of the dark centre of Newton's rings, indicating that contact (whatever contact may mean) between the glass surfaces extends over the central black spot. Fig. 1*b* shows the white spot beginning to disappear into the glass or into the water or simply contracting due to increase in pressure. At the rear of the moving Newton's rings pressure will be greatly reduced, so the white spot is probably mainly water vapour at low pressure. That the spot contains gases, however, can be shown by giving the top plate a jerk, when instead of the whole white spot disappearing "at the creeping in of the water," a tiny white bubble of gas may be seen remaining for a long time in the water between the glasses. The white spot can be observed perhaps better because with slower motion, if a viscous liquid such as strong sulphuric acid or vacuum pump oil be used instead of water, or even with a plastic solid like soft soap between the glasses.

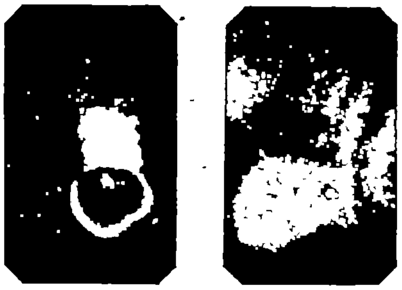

Fig. 1.

James Muir.

The Royal Technical College,
Glasgow, April 27.

An Arctic Peat in Ireland.

It has often been stated, and is very generally believed, that no deposits analogous to the Arctic peats of Scotland occur in Ireland. The proximity of the two countries is so great, however, that climatic conditions which affected Scotland must have affected at least the northern portions of Ireland in a similar degree, and it is not surprising, therefore, that an Irish Arctic peat, or something approaching one, has at last been discovered. This peat bed in question is situated on the boundary between the counties Dublin and Wicklow, on the eastern slopes of the Dublin mountains. Locally the place is known as Ballybetagh and Mulligan's Bogs, the former lying in Dublin, the latter in Wicklow. Both bogs have long been famous for the vast quantity of remains of the so-called Irish elk, which has been found beneath them.

The site of the bogs is an oval depression about half a mile long (north to south) by a quarter of a mile in width, and was occupied in late glacial and early post-glacial times by a (?) shallow lake, now entirely filled up by deposits of various kinds. The first post-glacial stratum to be laid down in the lake was a fine bluish-grey clay, sometimes containing chips of stone or gravelly layers, derived by subaerial denudation from the moraines surrounding the site. Resting on this clay, and often bedded into it, lie the scattered bones of the great deer; while in turn these are covered by a flaky peat—locally known as "elk deposit"—which, besides numerous seeds, roots, etc., contains many leaves of *Salix herbacea*. At present my claim that this is an Arctic peat rests solely on the evidence afforded by this willow, though I have just heard from Dr. G. Erdtman, of Stockholm, that a hurried and superficial examination of a sample of the peat from Mulligan's Bog has convinced him that it "is sub-Arctic, if not Arctic."

I have to thank Dr. Henry Stokes, of this city, for permission to examine numerous sections at Mulligan's Bog in August 1926, when he was digging for remains of the Irish elk. I have also to thank Miss M. C. Knowles, of the National Herbarium, for confirming my identification of the leaves of *Salix herbacea*. I may add that the leaves from Mulligan's Bog differ greatly from those of the same willow now growing in the Wicklow Mountains at altitudes of from 2000 ft. to 3000 ft., and resemble the leaves of prostrate specimens of the plant in the National Herbarium from Arctic Europe and Labrador. The present lowest limit of *Salix herbacea* in Wicklow is a little more than 2000 feet altitude, thus suggesting a considerable lowering of the snow-line during the period in which the peat was deposited, Mulligan's Bog being only about 750 feet above present sea-level.

There is at present no proof, but I suggest that the Irish elk may have lived during a comparatively mild period, and that the peat containing the leaves of *Salix herbacea* may be contemporaneous with one of the re-advances of the ice—when the Scottish ice sheet was forming its terminal moraines along the north-east coasts of Ireland, on the Isle of Man, Cumberland, and in south-west Scotland. For evidence connected with these moraines see "The Re-advance, marginal kame-moraine of the South of Scotland, and some later stages of retreat," by Dr. J. K. Charlesworth (*Trans. Roy. Soc. Edin.*, 1926), and also A. R. Dwerryhouse in *Quar. Jour. Geol. Soc.*, 79, 352; 1923.

A. W. Stelfox.

National Museum,
Dublin.

Audibility of Gunfire.

In an article published in Nature last August the suggestion was made that it might be possible to utilise gunfire for accurate measurement of the time of passage of sound over long distances, and in a postscript to the article I was able to record my success in listening at Grantham for the sound of guns discharged at Shoeburyness. On that occasion the interval between the firing of the gun and the arrival of the sound at Grantham varied between 10¾ and 11¼ minutes.

It is now agreed that 'abnormal' audibility at great distances is due to the refraction of the sound waves in a region at a height of 40 kilometres or more where the temperature of the air is comparatively high. More observations are required to elucidate various problems concerning this region. It is therefore gratifying that the War Office has given approval to the proposal to broadcast the times of firing of one of the guns at Shoeburyness and that the British Broadcasting Corporation is making the necessary arrangements. Full particulars will be announced shortly.

To take full advantage of the opportunity it will be necessary to supplement the aural observations by instrumental records of the aerial disturbance. I am therefore anxious to get into touch with any persons who are provided with apparatus suitable for the purpose. I believe that sets of sound-ranging equipment exist at certain universities and technical colleges. The co-operation of observers who had experience with such apparatus during the War and would be able to utilise it would be especially valuable; it would probably be possible to provide sets for them. It is anticipated that the best distance for successful observations will be at about 120 miles from Shoeburyness, but it will be worth while to attempt observations at rather greater distances, at such places as Nottingham, Birmingham, and Bristol. Records from comparatively near stations, which will be in the region of normal audibility reached by sound waves passing only through the lower atmosphere, are also desirable.

The experimental work on this subject has been done hitherto on the Continent. The trial which we are undertaking offers greater difficulties, as the explosion from which the sound is to originate will be so much smaller. Previous experience shows that as a general rule the zones of audibility are unsymmetrical, so that it is impossible to forecast where the sounds will be perceived. There is, however, reason to believe that in summer the region of abnormal audibility is likely to be to the north and west of the source of sound, so that our trial will be conducted in the most favourable circumstances.

I hope that those who may be able to co-operate in procuring instrumental records will kindly communicate with me at once. Others who are interested and will be able to make aural observations are asked not to write at present. Full details of the trials will be published as soon as possible.

F. J. W. Whipple.

Kew Observatory, Richmond,
Surrey, May 17.

Phytophagic or Biological Races in Insects.

I had no desire to enter into any controversial discussion with Dr. Heslop Harrison (whose letter in Nature of April 16, p. 562, I regret not to have seen earlier), either in regard to his experiments or the conclusions he draws from them; I sought only to obtain some explanation of an alleged 'new principle in evolution,' since anything that deserved such a title would probably be serviceable to me in my studies. I was fully acquainted with the previous paper to which Dr. Harrison refers, as I had particular occasion to consider it at its first appearance. This earlier paper related to the fixing of certain qualities of colour, etc., under chemical influences in food, and I could readily accept it; the second described the fixing of hereditary habits by slight changes of food plants in three generations, and was much less easy of digestion. Yet on the strength of this latter case only (for the former does not touch the real point, and is only connected with the latter by an assumption of a common explanation, a conjectural modification of a wholly supposititious germ-plasm) Dr. Harrison proceeded to specify a number of actual instances of pairs of allied species, particularly stated to be 'in Britain,' and well known to me, and to suggest that this case explained their origin. If he did not mean that they originated in Britain, why describe their British association? It is no evidence that they are similarly associated in Siberia.

I do not deny that food produces differences in species; on the contrary, I know it produces differences. I do not know that it produces specific differences, nor, I think, does any one else. But I cannot believe that in any single instance pairs of allied species come into existence as Dr. Harrison describes; he excludes the essential factor of isolation (either in space or time), without which it would be impossible to keep the two stocks distinct until they were fixed. My case is that many of the most obviously close pairs of species feed not on allied but on the very same species of plants in the same way (I will instance *Tischeria complanella* and *T. dodonaea* on oak, *Heliozela sericiella* and *H. stanneella* on oak, *Antispila pfeifferella* and *A. treitschkiella* on Cornus, all exceedingly close pairs), and that the law of averages renders it unlikely that the direct chemical influence of the food plant is often more effective in other categories than in these, where it is nil.

I should like to add, in relation to Mr. W. H. Thorpe's letter (April 23, p. 602), that the genus Hyponomeuta, on which he is working, does, in my opinion, offer the most suitable material known to me for investigations on the direct effect of food plants, and I trust he will obtain valuable results.

Edward Meyrick.

Thornhanger, Marlborough,
May 7.

The Chemistry of the Adrenal Cortex.

In a previous paper (*Biochem. Z.*, 181, 438; 1927) it was shown that extracts of the adrenal cortex strongly reduce silver nitrate and iodine. This reduction could not be accounted for either by adrenalin or glutathione, and seemed to be specific to the interrenal tissue. To exclude any anticipation of function and chemical structure, the substance giving this reduction was named by its protocoll-number "C_{XII}," being the twelfth substance prepared and examined in my work on tissue oxidation and the function of the adrenal cortex. Having been enabled to resume this work at the Biochemical Laboratory, Cambridge, the substance has been further investigated and finally isolated in crystals, which on recrystallisation showed a constant melting-point.

That C_{XII} is definitely confined to the adrena cortex can be easily demonstrated by the direct application of silver nitrate to the fresh-cut surface of the gland. If a cross-section is made through the (cow's) gland and the pieces immersed into a dilute

(0·2 per cent.) silver nitrate solution, the out surface of the cortex will be seen to turn almost black within a short time, while the medulla, like other organs, remains practically uncoloured.

The purification of C_m was based on the following properties: it is readily extracted by methyl alcohol and precitated almost quantitatively from its alcoholic (not from watery) solution by lead acetate. It shows a different solubility in organic solvents at acid or alkaline reaction. At an alkaline reaction it is readily soluble in water, methyl alcohol, sparingly in acetone, insoluble in ether and other more hydrophobe solvents, and is precipitated by these latter from its strong alcoholic solution. At acid reaction it is readily soluble in water, alcohol, and acetone, is not precipitated from alcohol by ether, but is carried down by this latter from an acetone solution. The substance does not form a precipitate with any of the great number of other precipitating agents applied. No colour reaction could be found. (The brown coloration on application of acid iodate, mentioned in the first paper, is caused by the liberation of iodine. My first impression that the substance was a thiophenol has been disproved, as no sulphur is found on analysis.) The substance has been crystallised in fine colourless needles from a hydrochloric acid solution, the crystals showing a constant melting-point of 175° C.

The C_m content of the adrenal gland (cow) is approximately 0·1 per cent. Preliminary experiments tend to show that the substance is not devoid of biological activity. My earlier experiments, showing that C_m is not the hormone of the adrenal cortex, seem in the light of Banting's and Rogoff and Stewart's recent work to be inadequate. Analysis of the biological significance and chemical constitution has been started. A full account of the methods of preparation will be given in another place.

A. v. SZENT-GYÖRGYI.

Biochemical Laboratory,
Cambridge University,
April 30.

Behind the Divining Rod.

RECENT correspondents have not referred to the views that place the use of the divining rod in the category of 'psychological automatisms' like the use of planchette or divination by a ring suspended in a tumbler. A simple experiment will demonstrate such an automatism. An unsuspecting subject is directed to sit leaning forward with his elbows resting upon his knees and with his hands placed just below the level of his eyes. The end of a watch-chain is placed in his hands with the watch dangling between his separated knees, and he is now assured that the watch will swing from knee to knee. Any plausible explanation may be given—bodily magnetism, or the inner movements of the watch—and, unless the subject be critically disposed, the watch as he gazes upon it will swing with increasing amplitude in the direction named. In an experiment with a fresh subject the watch, by suitable assurance, may be made to swing at right angles to its path in the first case.

The movement is produced unwittingly by the muscular action of the subject. The divining rod, as I have seen it used, provides a delicate mechanism by which muscular action can produce movements that the subject apparently, and in his own belief, is trying to resist. I have described the method in "Spiritualism and the New Psychology" (Edward Arnold, 1920).

Testimony as to the honesty of the dowser adds to the pathological interest of the phenomenon; conscious fraud is less pathological than a mild dissociation of personality. Prof. Sollas rightly insists that in tests of ability to 'dowse' coins the investigator himself should not know what they are, but there is no need to invoke telepathy. There is a super-acuity of the senses, in the presence of a mental dissociation, that enables the 'dissociated' subject to pick up the slightest indications from bystanders or otherwise.

The divining rod has had many uses: to find water, coal, ore, hidden treasure, criminals, and witches. Mechanically and psychologically it belongs to the same category as planchette. Pierre Janet dealt fully with this and other psycho-pathological manifestations in "L'Automatisme psychologique" (Paris: F. Alcan, 1889) and remarked (p. 368): "Il est probable que, dans quelques campagnes, subsiste encore la croyance aux révélations de la baguette divinatoire."

MILLAIS CULPIN.

1 Queen Anne St.,
London, W.1.

Gallium in Flue Dust.

MR. W. KIRBY'S observation of the occurrence of the element mercury in coal-tar, recorded by Dr. Aston in NATURE of April 2, p. 489, is another instance of the wide distribution of an element in minute quantity. Employing the method of spectrum analysis by oxy-hydrogen or oxy-coal gas flames (Hartley and Ramage, *Trans. Chem. Soc.*, 71, 533, 1897, etc.) in a search for sources of potassium in flue dusts during the War, certain samples were found to contain notable quantities of gallium. Experiments have been made as occasion permitted to perfect a method for extracting that rare metal from Norwich Gas Works' flue dust, derived from South Yorkshire coal, and in the course of the work the presence of the following elements has been noted: lithium, sodium, potassium, rubidium, cæsium, copper, silver, calcium, strontium, zinc, aluminium, gallium, indium, thallium, carbon, titanium, silicon, lead, vanadium, phosphorus, arsenic, antimony, bismuth, oxygen, chromium, molybdenum, sulphur, manganese, chlorine, iron, and nickel. Circumstances have not permitted a complete analysis to be made, and one substance, at least, awaits final purification and identification. Certain selected pieces of dust, partially fritted, apparently contain about 2 per cent. of gallium, and the proportions of zinc and vanadium are probably higher still.

HUGH RAMAGE.

Municipal Technical Institute,
Norwich.

Distinctive Colour Senses of Artists.

THE article in NATURE of May 14 on the exhibition of the Royal Academy reminds me of a discussion I once had with a brother of Sir Charles Walston, who was a medical man interested in art. He was looking out for a method to determine the average colour of a picture, which he thought was characteristic of the painter, and might serve to identify him as certainly as finger-prints identify persons. I could only refer him to the method tried by the third Lord Rayleigh, when instead of spinning colour discs he looked at the stationary discs after reflexion from a surface that could be set into rotation. Applied to a painting, this would then give the average colour for concentric circles round the centre of rotation.

While I am writing, I am looking at portraits of two ladies made by the same artist. The dress of one is bright yellow, that of the other dark blue, and their average colour is not balanced by the colour of the background. The conclusion to be drawn is, that it is dangerous to mix science and art, though we may apply one to the other.

ARTHUR SCHUSTER.

Yeldall, Twyford, Berks,
May 18.

The Essential Oils of the Eucalypts.

By Prof. JOHN READ, University of St. Andrews.

THE timbers and the resinous exudations, or 'gums,' of the eucalypts have deservedly attracted much attention; but chemically, if not economically, the greatest interest of this leading genus of Australia centres around the eucalyptus oils. These 'essential' oils are produced abundantly in the minute leaf-glands of the eucalypts, and sometimes they may also be distilled from the bark and timber. Essential oils, as the name indicates, possess fragrant odours; they are more mobile and more volatile than the 'fixed' plant oils, with which they must not be confused; further, unlike the fixed oils, they are unassimilable, being in no way related to the fats.

The early settlers in Australia were quick to notice the value of the eucalypts as sources of essential oils. Dr. John White, surgeon-general to the first settlement, attracted by the strong peppermint odour of a common species growing around Port Jackson, was led to make the first distillation of a eucalyptus oil in 1788. In his "Journal of a Voyage to New South Wales" (1790, p. 227) it is recorded that "the name Peppermint Tree has been given to this plant by Mr. White on account of the very great resemblance between the essential oil drawn from its leaves and that obtained from the Peppermint (*Mentha piperita*) which grows in England. This oil was found by Mr. White to be much more efficacious in removing all cholicky complaints than that of the English Peppermint, which he attributes to its being less pungent and more aromatic." The species of eucalypt which furnished this oil is now known as *Eucalyptus piperita*, and it is common in the Sydney district and the Blue Mountain Ranges of New South Wales. It was sixty-six years later that the first eucalyptus oil factory was established in Australia by Bosisto, while the first chemical investigation was made by the French chemist, Cloëz, in 1870, upon an oil yielded by specimens of *E. globulus* grown in France. Such were the modest beginnings of the utilisation and scientific examination of eucalyptus oils.

Every Australian knows that a eucalyptus leaf, when crushed, often emits an agreeable odour; many know that these odours may vary considerably, from tree to tree, throughout a stretch of bush; and some are able to effect a rough classification of these trees, based upon such observations. Few, however, are able to proceed beyond this point, and it is remarkable that so little exact knowledge should exist, in the popular mind, of a genus which is rightly held in such esteem as an emblem of Australia. In remote parts of Tasmania 'bushwhackers' born and bred among the eucalypts have been known to assert that there are five kinds of 'gums'; but Australian men of science who have devoted their lives to a study of this wonderful genus have distinguished some two hundred and fifty species, and the tale is even yet incomplete. So interwoven are the relationships, so refined the distinctions, that in some instances discrimination between closely related species has been rendered possible only through the combined efforts of the botanist and the organic chemist. Investigations of this nature, which were prosecuted with unflagging zeal through a period of more than thirty years by R. T. Baker and H. G. Smith, of the Sydney Technological Museum, have demonstrated the remarkable constancy of composition of the leaf-oil derived from any particular species of eucalypt, and have rendered possible a chemico-botanical classification of the various species, through the elucidation of certain remarkable relationships between chemical and botanical characteristics in the genus.

It is usually taken for granted that 'eucalyptus oil' consists mainly, or wholly, of the familiar eucalyptole, or cineole, the smell of which is so familiar during epidemics of colds and influenza. In point of fact, however, cineole is merely one out of about forty chemical components which have been discovered in the oils of this genus since 1870. According to the interesting evolutionary theory of Baker and Smith, the original eucalypts were evolved in north-western Australia, from the still older genus Angophora, and such species still predominate in this region; the leaves in this group, of which the well-known Bloodwood (*E. corymbosa*) is an example, possess a 'feather' venation and are very poor in oil, of which the main component is the turpentine hydrocarbon, pinene. At the other end of the evolutionary scale, the most recently evolved species occur mainly in the south-eastern portion of the continent; the leaves have a 'butterfly-wing' venation and are thickly studded with oil-glands, so that the yield of oil may exceed four per cent. of the weight of the leaves and twigs. The Broad-leaved Peppermint (*E. dives*), a widely distributed member of this group, furnishes an oil consisting largely of phellandrene, in association with an interesting peppermint ketone, called piperitone, which promises to assume considerable importance as a commercial source of synthetic menthol and thymol. Certain oils in this group are used also in the flotation process for the separation of metallic sulphides from their ores. Cineole is the chief component of the oils from an intermediate group of eucalypts; it occurs as a rule in association with pinene, in such species as *E. globulus*, *E. Smithii*, *E. Australiana*, and many others. Oils of this type are used largely in pharmacy, and they are sometimes so rich in cineole that the crude 'first-hour oil' readily deposits a solid glacial mass of this substance when placed in a freezing chamber.

Chemically, therefore, it is possible to discern three main groups of eucalyptus oils; but in addition there are many exceptional species the leaf-oils of which contain such valuable components as geraniol (*E. Macarthuri*), citronellal (the Citron-scented Gum, *E. citriodora*) and citral (the Lemon-scented Ironbark, *E. Staigeriana*). As a rule, each chemical constituent is found to increase through a range of species until it reaches a maximum value in the final member. In exceptional cases, such as that of *E. Macarthuri*, the end species alone appears to have survived. In spite of the intricate relationships in the genus, ability to discriminate between the main types is not particularly difficult to acquire. As a practical aid in such studies, an interesting record of the character of the leaf-venation and the disposition of the oil-glands may be obtained by making direct sun-prints of the leaves on sensitised paper. The identification of indigenous species in any particular area is helped by the fact that the chemical fastidiousness of the eucalypt is accompanied by an equally marked susceptibility to environment, so that changes in such factors as geological formation, rainfall, and altitude are reflected in the character of such species.

In harvesting eucalyptus leaves for distillation the trees may either be lopped or felled, and although the latter method may appear extravagant, yet experienced distillers often favour it. The phœnix-like eucalypt conforms to the general motto of the Australian flora, which is 'Resurgam!' It combines amazing vitality with unusual rapidity of growth; and so, after the lapse of a few years, the decapitated stump may have surpassed the ideal of Dean Swift by producing not merely two, but three, or even four, sturdy trunks where only one grew before. To that bizarre list of alleged Australian paradoxes which circulates so freely outside Australia, to the mingled amusement and annoyance of good Australians, may thus be added the less familiar but more truthful statement that a lopped or felled eucalyptus tree, rising on the stepping-stone of its dead self, may in a few years develop more foliage than it originally possessed.

The mallee scrub in the Wyalong district of New South Wales is treated in a still more drastic manner. The mallee, a type of eucalypt embracing many species, is a dwarfed form, having a number of small stems instead of the usual single trunk. In the western part of New South Wales, as also in South Australia and other regions, mallee eucalypts cover vast areas, and the essential oil of the Blue Mallee (*E. polybractea*), the dominant species in the Wyalong district, is worked extensively for cineole. A second species, *E. oleosa*, or Water Mallee, secretes water in its roots, a fact which was fully appreciated by the aboriginal inhabitants of Australia. Other important mallees are *E. odorata* and *E. cneorifolia*, from which the bulk of the South Australian eucalyptus oil is extracted; the last-named species occurs only on Kangaroo Island. In dealing with the Blue Mallee, the oil distiller flattens and partly uproots the mallee scrub by driving a heavy roller over it; and after the hardly used vegetation has dried in the sun he completes its apparent destruction by burning it off. The bare waste which repels the eye at this juncture seems to be devoid of any germ of life. In a short time, however, the irrepressible eucalypt reappears; a pleasing dull blue mantle of *E. polybractea* covers the landscape; and after the interval of a year the oil distiller is gladdened by the sight of a luxuriant growth of mallee rising to the height of his waist.

The harvesting of eucalyptus leaves from the mallee forms is simpler than from the trees, but the subsequent operations are the same for material from either source. In order to liberate the oil, the leaves are brought into contact with steam, which ruptures the oil-glands and causes a slow vaporisation of their contents. The primitive form of bush-still consists of the cubical iron tank so familiar to Australians; this contains the tightly packed leaves resting upon a grating, below which water is boiled by means of a wood fire underneath the tank. As the steam forces its way up through the mass of leaves it becomes charged with the vaporised oil, and the mixed vapours are condensed during their passage through an exit tube cooled by immersion in a creek, or in some more refined manner. The resulting mixture of water and oil runs down the tube and is collected in a receiving vessel, which is so constructed as to allow the relatively small layer of oil to be drawn away from the water upon which it floats. Other types of plant possess an independent boiler which supplies steam under pressure to a series of digesters, these latter being sometimes sunk into the ground to facilitate the handling of the fresh and the spent leaves.

The prices realised by eucalyptus oils range over a wide scale. The value of the oil depends upon its chemical composition, which, although sensibly constant for any particular species, varies enormously from one species to another. The Blue Mallee, for example, yields a cineole oil having a market value of somewhat more than a shilling a pound to the distiller, while the citronellal oil of the Citron-scented Gum of Queensland brought in as much as six shillings per pound during the War. The reputation of the cineole oils has suffered in the past, owing to the multiplicity of species yielding such oils and to the confusion which has existed between these species in the field. A vernacular name, such as Messmate, may easily be interpreted in half a dozen different ways, according to the tastes of the individuals concerned. It is therefore a satisfaction to find reputable oil distillers adopting the systematic Latinised names; and although the use of scientific nomenclature in the Australian bush may occasion some degree of surprise, yet—as a 'bushwhacker' once remarked in different words—there is nothing inherently difficult in the pronunciation of 'Eucalyptus Macarthuri,' and the name is decidedly more euphonious than the synonymic Camden Woolly Butt or Paddy's River Box. Fortunately, neither *E. Luehmanniana* nor *E. macrorhynca* is worked for oil!

As his readiness to use these strange names shows, the oil distiller is eminently adaptable; he has been known to write his letters with home-made charcoal ink by the light of a lamp burning the oil of *E. Macarthuri*. He is, indeed, a virile and picturesque Australian type, full of the lore of the bush. Let us hope that some day an Australian master will arise to do by him as Thomas Hardy has done by the tranter and the reddleman of Wessex.

Evolutionary Advance: Emergent and Resultant.[1]

By Prof. C. LLOYD MORGAN, F.R.S.

THERE seems to be not a little misapprehension as to the position which those who advocate emergent evolution are concerned to defend. Some critics seem to suppose that the contention is: All evolution is by discrete steps, each of which introduces something new; therefore no evolution is by continuous advance with resultant outcome. That is not so. At any rate, I, for one, disclaim intention of saying anything of the sort. It has been my aim to emphasise the claim that what is genuinely new in evolutionary advance is of the emergent type, as distinguished from the resultant type. My claim is: Some evolution is by discrete steps, each of which introduces something new. But stress on emergent factors in evolution does not imply denial of resultant effects.

When we consider organic evolution this must be borne in mind. If the biologist adduces thousands of examples of changes in living organisms which are interpretable mechanically as strictly resultant, that is no argument which serves to disprove the occurrence of changes which, as we think, must be interpreted as strictly emergent. If both types of change are in evidence, our aim should be to distinguish the one type from the other.

The emergent claim is (1) that there are certain characterising features of the living that cannot be deduced from our knowledge of what happens on the lower platform of the not-living. But the further contention is that this holds good, not only for the living and the not-living, but also at many stadia of evolutionary advance; so that, on like empirical grounds, we may say, for example (2), that there are certain characterising features of the molecule that cannot be deduced from our knowledge of what happens on the lower platform of the atom.

It is with the former claim that we are here concerned. Then the trouble is that one who advocates emergent evolution is sometimes supposed to deny resultant evolution. He is supposed to say in effect: *Not* resultant advance, *but* emergent advance.

Let us consider the attitude of those who do nothing of the sort. In resultant advance the conditions are such that there is homogeneous continuity. Hence deductive conclusions are relevant all along the line of advance. With adequate knowledge of the law of such advance, predictions as to the exact nature of any later phase could be made on the basis of adequate and sufficient knowledge of any earlier phase. Hence the unlimited range of astronomical predictions in so far as they are based on the principles of resultant mechanics.

Now what is the bearing of this on the vexed biological issue? The 'mechanist' says in effect that all processes and products from first to last—from the not-living to the living organism—are susceptible of resultant interpretation. They are all on one continuous plane of resultant advance. And he points with justifiable pride, which others may share, to the outcome of such treatment. There are, no doubt, as he frankly admits, sundry physiological processes which still present difficulties. What of that? Further research on this method of interpretation will resolve them in due time.

What, then, say those who have been led to accept emergent advance? Do they deny any one of the successful achievements based on resultant treatment? They do not. What they do submit is that there are modes of 'behaviour' in the clustering of events within the living organism that are of such a nature as not to be deducible from that which obtains in the not-living. They submit, in further detail, that there are *some* physiological processes which elude the meshes of the resultant net, which are on a different level of emergence, which could not be predicted from the not-living platform.

It may be asserted that with further knowledge it will be shown that there are *no* physiological processes that elude the resultant net. We are, however, dealing with matters as they now are; and our attitude is: Resultant advance in plenty; as much as can be proved; but not a few residual matters which bear witness to emergent advance. If this be so, is not the present position of affairs this: The living organism in physiological regard is such as to exemplify evolutionary advance, not resultant only, not emergent only, but both resultant and emergent?

Should not this be our attitude in broader biological regard? Now that the concept of emergence has been admitted into the field of serious discussion, there is grave danger of its being used wildly and without discrimination as a popular catchword. People talk of the emergence of the elephant or the mongoose; the emergence of the social Hymenoptera, of polymorphism in ants; perhaps the emergence of mimicry or of display in courtship.

It may, however, be said: We thought that evolutionary advance is what you stand for. But now it seems that you propose to introduce sundry rather puzzling reservations. If polymorphism in ants—to select one of your examples—if, in other words, the differences of structure and diversities of behaviour that characterise the constituent members within some social community of ants, be not the outcome of evolutionary process, of what natural process is all this the outcome?

I do not suggest that all this is not the outcome of, or does not afford an instance of, *evolutionary* advance. My aim is to distinguish, within this advance, (1) that which is deducible on the method of resultant treatment, from (2) that which is not deducible on this method. The former I speak of as resultant advance; the latter as emergent advance. I submit that, on the evidence, we find in the field of biological inquiry both emergent and esultant advance. My plea is for careful analysis.

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[1] From a paper read at a meeting of the Aristotelian Society on Feb. 14.

There are a good many critics who seem not yet o have grasped just where the concept of emergent evolution is applicable. They seek to apply it where I, for one, hold it to be inapplicable. They may then ask: What bearing has this concept of emergence on the theory of natural selection? It may savour of extravagance if I express the opinion hat on this theory, as such, it has little or no bearing.

To make my meaning clear, I must ask: Are we, under natural selection, dealing with the survival of variants or with the origin and transmission of variations? In the opinion I express I assume that he theory of natural selection *as such* deals with variants, and that the origin and transmission of variations fall for discussion under a different theory—that of genetics. If this be so, the issue for natural selection is a plain issue. Are some variants weeded out in 'the struggle for existence' or are hey not? If some are weeded out, leaving others to survive, I regard such elimination as a resultant effect.

That leaves the origin of variations (or of mutations) to be discussed as a separate issue under genetics. It opens up a wide field of inquiry, including Mendelian research. Here the question does arise: Is this or that variant the outcome of resultant, or emergent, advance; or is it a joint product of both? If both are given in the evidence, the emergent factors should be distinguished.

My plea is: If the concept of emergence be accepted, let us make quite clear just where this concept is applicable. When I express the opinion that it is not applicable to natural selection, as such, it should be obvious that this does not preclude the survival of those variants which have genetic characters that can be shown, under searching analysis, to be emergent in origin. Biological inquiry includes both natural selection and genetics; and genetics discloses, as I think, both emergents and resultants. Is there not pressing need for the exercise of distinguishing analysis?

Fat-soluble Vitamins.

BARELY two decades have elapsed since the concept of 'vitamins' first began seriously o attract the attention of investigators. Scurvy had been recognised as a clinical entity for a couple of centuries, and the treatment of it, by means of fresh vegetables and fruit juices, was well known. But the idea that disease might be caused by the *deficiency* of some factor in the diet was, for many, too novel to be accepted without question, and much work was necessary before the reality of the accessory food factors or vitamins was generally admitted. Recognised at first solely by the effects produced on experimental animals when absent from their carefully purified diets, it was not long before chemical investigations began to define their properties, from which tentative conclusions as to their chemical nature might be drawn. With the discovery that ultra-violet light could cure rickets, and was also capable of making a diet, previously inactive, protective against this disease, a new key was provided for the unlocking of the door which led to the chemical constitution of the anti-rachitic vitamin, or vitamin D, as it is also called. At this stage the work came into contact with other investigations on a group of compounds of widespread distribution in Nature, but of almost unknown biological significance, the sterols. At the present time it is certain that vitamin D, if not actually a member of this group, is closely related to one, and it is extremely probable that vitamin A, or the fat-soluble growth-promoting vitamin, is also of a similar nature.

Following the discovery that exposure to ultra-violet light could render a deficient diet anti-rachitic, it was soon found that the unsaponifiable fraction of the fat of the diet was responsible for his effect. O. Rosenheim and T. A. Webster, working at the National Institute for Medical Research, and Steenbock and Hess and their collaborators in America, then discovered independently that 'chemically pure' cholesterol was rendered anti-rachitic by this exposure. Further work by these and other investigators has now sufficed to determine more definitely the properties and nature of the compound which undergoes this change, although the actual nature of the change itself is undetermined.

Rosenheim and Webster (*Biochem. Jour.*, 1926, vol. 20, p. 537; *Lancet*, 1927, vol. 1, p. 306) were unable to convert more than 0·1 per cent. of cholesterol into vitamin D under the influence of ultra-violet light. They also showed that the presence of the unsaturated linkage and of the secondary alcohol group of the sterol was essential for the reaction to take place, and that the vitamin was not precipitable by digitonin. The fact that only a minute amount of the cholesterol could be 'activated' raised a doubt as to whether this substance was the true precursor of vitamin D, and the doubt became a certainty when it was found that cholesterol purified by way of the dibromide could not be activated and, moreover, no longer possessed the characteristic absorption spectrum in the ultra-violet region. These experiments proved that the vitamin precursor is not cholesterol itself, but some substance which is closely associated with it when obtained from all natural sources.

Further work showed that the precursor was easily oxidised and could also be precipitated by digitonin, unlike the vitamin obtained from it. Attempts to separate it from cholesterol by making use of the latter property, or by fractional crystallisation (Heilbron, Kamm, and Morton, *Jour. Soc. Chem. Ind.*, 1926, vol. 45, p. 932) or by fractional distillation in a high vacuum (Windaus), resulted in a considerable concentration of the precursor, but it was not obtained in a pure state.

The authors therefore selected another sterol, ergosterol, which they had previously shown could be rendered anti-rachitic by ultra-violet light, for further examination, since it possesses some of the properties of the vitamin precursor: thus, it cannot be recovered unchanged from its bromide (Windaus), it is extremely sensitive to light and oxidation, forms an insoluble digitonide, and possesses three unsaturated linkages. It was found that this sterol exhibited a very pronounced absorption in the ultra-violet region of the spectrum, which disappeared on irradiation; at the same time the product lost the property of being precipitated by digitonin. Experiments on rats suggested that the limit of anti-rachitic activity will be in the region of a daily dose of $\frac{1}{1000}$ mgm. or less.

It is therefore probable that the vitamin precursor is really ergosterol: similar or identical sterols have been found widely distributed throughout the lower plants. Thence they must find their way into animals, thus enabling the latter to develop their own anti-rachitic vitamin on exposure to light. The anti-rachitic power developed by cholesterol on irradiation, then, is due to contamination of this compound with ergosterol; from the intensity of the ultra-violet absorption spectrum it appears that this contamination occurs to the extent of about 0·05 per cent.: this assumption also explains the impossibility of making anti-rachitic more than a small amount of the "cholesterol."

Less is known at the moment about the nature of the fat-soluble vitamin A. Like vitamin D, which has only recently been definitely differentiated from it, it occurs in the unsaponifiable fraction of the fats and oils (notably codliver oil) in which it is present. Following the work of Drummond, Takahashi, and other investigators, certain of its properties have become established (see NATURE, 1926, vol. 117, p. 522, and J. C. Drummond, H. J. Channon, and K. H. Coward, *Biochem. Jour.*, 1925, vol. 119, p. 1047). Thus the vitamin A present in the cholesterol-free oil obtained from the unsaponifiable matter of cod-liver oil can be distilled at low pressure at a temperature of about 180°-220° C.: only small amounts are obtained, the greater part of the purified oil consisting of unsaturated alcohols together with a certain amount of squalene. Even the product obtained in this manner is impure, so that Drummond was unable to agree with Takahashi with reference to the claim advanced by the latter that he had isolated the vitamin in a pure state. Drummond noticed that the growth-promoting activity was retained after destruction of the hydroxyl group of the alcohols present, but was always destroyed by exposure to reagents which affected the unsaturated linkages. More recently Rosenheim (*Med. Res. Council Rep.*, 1925–6, p. 30) has found that partial oxidation of cholesterol produces a substance which gives the colour reaction characteristic of vitamin A (and a few other substances). It is therefore possible that vitamin A may also be found to be a derivative of one of the sterols.

The story of the work on the fat-soluble vitami
A and D shows how two entirely different lines
research may suddenly converge, and how a purel
academic investigation may suddenly assume
definite practical importance. Without the know
ledge obtained from the work of previous i
vestigators on the sterols, the biological importan
of which was not at the time obvious, it is possib
that the isolation of these two vitamins would hav
taken much longer than it now seems probab
will be the case.

The practical application of these researches
the prevention and cure of rickets is obvious: bu
this is not a very common disease, so that it
worth inquiring if deficiency of these vitamins ma
play a part in other diseases or states of ill-healt
Drawing an analogy from the symptoms show
by rats suffering from deficiency of vitamin A,
is probable that this vitamin plays a part
maintaining the various mucous membranes
the body in a healthy state, quite apart from an
effect it has on proper growth: in fact, deficien
of this vitamin has led to the appearance
xerophthalmia in human beings just as
experimental animals.

At the same time, increasing light is being throw
on the relationship between vitamin D and t
formation and decay of the teeth, a subject of ver
great importance. Mrs. Mellanby first demo
strated this relationship in the case of animals, b
the application to human beings was not i
mediately obvious, since dental decay occu
frequently in apparently perfectly formed teet
Mrs. Mellanby has, however, found (*Med. Re*
Council Rep., 1925–6, pp. 18 and 74) that teet
normal to naked-eye examination, may sho
defects of structure of both the enamel and denti
when examined microscopically. Decay was almo
general in these teeth, whilst only one-quarter
the well-formed teeth were affected.

With C. L. Pattison, Mrs. Mellanby has i
vestigated the extension of caries in children
different diets, and has found that increasing th
vitamin D and decreasing the oatmeal has reduc
the extension, when compared with less satisfactori
constructed diets.

The fact that apparently well-nourished peop
give signs, in the structure of their teeth, of
specific vitamin deficiency in their diet, is of gre
interest. It suggests that the supply of vitam
has been inadequate, and that in the competitio
for the amount provided in the diet, the teeth fa
to obtain their due share. This work brings th
problem of dental decay within the sphere
nutrition, and points the way to effective preve
tion: either the diet must be improved by th
increased use of natural foodstuffs containi
the vitamin, or a palatable and cheap source
the vitamin must be available. The work on th
irradiation of ergosterol gives grounds for su
gesting that it may be possible to provide,
the near future, vitamin D in a highly conce
trated form, to be used either by itself as a med
cament or for the enrichment of suitable articl
of diet.

Obituary.

Dr. W. Collingridge.

Dr. WILLIAM COLLINGRIDGE, who died on April 29 at seventy-three years of age, went up to Cambridge as a young man, and while there his medical studies were interrupted by the circumstance that he volunteered surgical services to the Serbian Forces during the Turko-Serbian War. On his return to England he resumed his studies at the University and graduated in medicine. After two years of private practice he was appointed (1880) Medical Officer of Health of the Port of London, and during his twenty years' tenure of this post he contributed materially to the advances made in port sanitary work. The period was an eventful one; for two continental epidemics of cholera seriously threatened Great Britain, and the measures he devised and conducted were of great assistance in securing the immunity from infection which London, and the country generally, enjoyed. In no small measure are we indebted to Collingridge for the comparative composure with which we should face such risks at the present day.

Collingridge's special knowledge and experience led him to become a great opponent of the old practice of 'quarantine'; and this was the subject which he discussed, most ably, in his Milroy Lectures to the Royal College of Physicians (1897). He maintained that no attempt should be made to enforce quarantine in a commercial country, now that other more satisfactory measures of safety were available; and he gave opinions supported by facts that such measures had certainly been evolved. Quarantine was expensive; it often failed, and thus gave a false sense of security; and it involved serious danger to those detained on the ships. Sanitation, the medical inspection of passengers and crew at some suitable mooring station, the hospital isolation of infected persons and the temporary detention of suspects, constituted a scheme which presented many advantages. These views have now met with a very wide acceptance. It was also during these years that he became a warm advocate of improved sanitary conditions in the mercantile marine; and he was a pioneer in securing such improvements, although the existing conditions still leave much to be desired.

In 1901, Collingridge was appointed Medical Officer of Health for the City of London—a post which he retained until 1913. It was inevitable that in this sphere of work also he would leave a deep impress of progress in measures to promote the public health. He recognised the danger from oysters bred in waters polluted with human sewage, and his persistent advocacy of the adoption of protective measures led to useful progress towards safety. He extended these operations to what he styled "the poor man's oyster"—the cockle—to the consumption of which he attributed, with good cause, much preventable illness. He always impressed the public health need for cleaner milk and did much to secure this in the City of London.

After his retirement from public health official work, Collingridge still remained deeply interested in public health matters. Throughout the War he was in charge of Auxiliary Military Hospital No. 112 in Kent. He maintained to the end his connexion with the Royal Sanitary Institute, of which he had been a member of Council and with which he was connected for nearly fifty years.

Prof. D. A. Gilchrist.

By the sudden death of Prof. Douglas Alston Gilchrist, professor of agriculture, University of Durham, Armstrong College, Newcastle-on-Tyne, on April 4, agricultural education and the agricultural industry of Great Britain have suffered a great loss. Prof. Gilchrist was the son of a west of Scotland farmer, and after leaving school, spent twelve years in practical farming, in which period he secured a thorough knowledge of the practical work and problems of farming. Afterwards he commenced to attend agricultural and science classes at the Glasgow and West of Scotland Technical College, and later made his way to Edinburgh, where he graduated B.Sc. (in agriculture) in 1889. In addition he obtained the senior certificate of the Royal Agricultural Society of England, and the diploma in agriculture of the Highland Agricultural Society of Scotland. In 1903 he was granted, by vote of Convocation, the degree of master of science in the University of Durham.

Bangor (North Wales), Reading (south of England), and Newcastle-on-Tyne were the three centres of Prof. Gilchrist's life work. He also visited France, Holland, Italy, Germany, and Canada, with the object of knowing something of agricultural education, research, and the practice of agriculture in these countries. In 1902 he was appointed to the chair of agriculture at Armstrong College and scientific director of the Northumberland County Experimental Station at Cockle Park. The abundant labours of the past twenty-five years are known and appreciated by a vast number of agriculturists, not only in Great Britain, but also all over the world. He was best known for his research in connexion with grass and clover seeds mixtures, and the improvement of permanent grassland by means of economic dressings of phosphatic manures.

When Prof. Gilchrist came to Newcastle there were six academic members on the staff of the Agricultural Department of Armstrong College. There are now sixteen such members, six of whom are advisers, the College being the northern provincial centre of higher agricultural education of the Ministry of Agriculture. By his writings and lectures delivered in various parts of the country Prof. Gilchrist was well known all over England. The experiments and demonstrations he organised at Cockle Park have had a marked effect upon farming in the north of England as well as in other parts of the country. He was much beloved by his colleagues on the staff of the Agricultural Department and his many students.

News and Views.

At the recent monthly meeting of the Zoological Society, the Duke of Bedford presented the bronze medal of the Society to Keeper E. Bowman for the successful rearing of the young male hippopotamus which was born in the Society's Gardens at Regent's Park last August. A similar award has not been made since the year 1872, when the last baby hippopotamus was reared by Michael Prescott and Arthur Thomson. This animal was "Guy Fawkes," who afterwards lived for thirty-six years at the Zoo. In nine months the present youngster has trebled his birth-weight, which was in the region of a hundredweight, and now seems to be well on the way towards equalling the record set up by his famous predecessor. Some interesting facts were recorded at his birth and during the time which followed. From the Keeper's own observations in this case and previous records made by A. D. Bartlett in 1871 and 1872, the period of gestation for the hippopotamus has been fixed at 240 days. The mother's behaviour immediately before parturition indicated that in Nature birth probably takes place in very shallow water or in a bed of reeds at the water's edge. Although unable to stand or walk properly, the young one shuffled along on his knees into the water a few hours after birth and swam round the pond with his mother. After a time the mother submerged her body entirely and turned on her side. The young one immediately began to suckle under water, coming up to breathe at intervals varying from twenty to forty seconds. This he has continued to do up to the present time, although he has now cut a good set of milk teeth and is able to eat a certain amount of solid food. He has occasionally been observed to remain under water for so long as three minutes while suckling. The average time for an adult hippopotamus to stay submerged is four minutes.

Dr. A. C. D. Crommelin, who retired from the Royal Observatory, Greenwich, on May 11, after thirty-six years' service, was educated at Marlborough and Trinity College, Cambridge. After a short time as assistant master at Lancing, he obtained by competitive examination a post as junior assistant at Greenwich in 1891. Dr. Crommelin was a regular observer with the transit circle, altazimuth, and Sheepshanks' equatorial. He had a wide general knowledge of astronomy and became an authority on questions connected with comets, minor planets, dates and times of eclipses, etc. His frequent notes on comets and his annual reviews on minor planets, as well as the physical ephemerides which he calculated for objects in both these groups, have been of great service. It was Dr. Crommelin who suggested to Dr. Cowell that they should calculate the 1910 return of Halley's Comet, and by the elegant method devised by Cowell, they predicted the return correctly to two days. For this they received a prize offered by the Astronomische Gesellschaft and the degree of D.Sc. from the University of Oxford. Dr. Crommelin went to the eclipses of 1896, 1900, and 1905 and had the good fortune to take part in the observations in 1919 which verified the bending of light predicted by Einstein. He has served on th Council of the Royal Astronomical Society since 190 and was secretary from 1917 until 1923. He ha also been on the council of the British Astronomical Association since 1896 and was president 1904–1906 Dr. Crommelin is such an enthusiastic astronome that his work will not cease with his retiremen from Greenwich. He has for several years been the chief contributor of notes in our Astronomica Column, and we hope to continue to have the advantage of his valuable co-operation.

According to an announcement circulated by Science Service, of Washington, Dr. H. Fairfield Osborn has reported to the American Philosophica Society the discovery of fossil bone implements in Nebraska of Pliocene age. More than three hundred implements of forty different types have been found They are made of the fossilised bones of extinct animals—camels, horses, deer, elephants, and mastodon. The exact locality of the discovery is not disclosed, beyond that it is in western Nebraska in order to protect the site. The first find was made two years ago, and since then machinery has been used in excavating the area. Two localities about 75 yards apart have produced most of the finds Dr. Osborn regards the implements as of undoubted human origin. Among them are skin dressers, awl-like implements, neck ornaments of strung bones, and a comb-like form that may be a tatooing implement. Eighteen of the types have been matched with counterparts from the ruins of cliff-dwellers of the south-west, and one can be nearly duplicated by a much more recent implement from a shell-mound in eastern America. Pending further information as to the geological evidence upon which the date of these implements has been determined, judgment must remain in suspense, although the opinion of Dr. Osborn must be given full weight. The comparison with the implements from the cliff dwellings is not necessarily reassuring until we know the types which present these similarities and have indubitable evidence of their high antiquity. Should this be established, the discovery will give strong support to those who have favoured the human character of the tooth discovered in the Pliocene of Nebraska a few years ago.

Faraday's lecture theatre at the Royal Institution was on May 18 the scene of a meeting of the Chemical Society and its distinguished guests, amongst whom was Lord Balfour, to hear the Faraday Lecture delivered by Prof. Richard Willstätter, whose discourse was devoted to a consideration of problems and methods in enzyme research. Taking Faraday's experiments "on the power of metals and other solids to induce combination of gaseous bodies" as the tarting-point in his discussion of organic catalysts, Prof. Willstätter said that the catalyst may function in degrees of association with the substrate varying rom fixation to approach, the continuous distribuion of electrical charges of the catalyst and the substrate mutually influencing one another. Platinum is capable of transferring hydrogen catalytically only in the presence of oxygen, hence the oxygenated platinum may be regarded as comparable with the enzyme-activator complexes. No single hypothesis s adequate to explain all the phenomena, but in enzyme chemistry no theory is so fruitful or so satisfactory as that assuming the existence of intermediate compounds between catalyst and substrate. The enhanced effects produced by mixed inorganic catalysts are closely analogous to the differences in potency and specificity exhibited by such enzyme systems as trypsin and trypsin-kinase or papain and papain-hydrogen cyanide. These catalytically active mixtures may be of the nature of new chemical compounds; the assumption that the admixture to the simple catalysts merely increases the frequency with which the catalytically active atoms stick out from the lattice is inadequate.

Prof. Willstätter dealt also with the problem of the isolation of the enzymes in a state of purity, a problem which is in process of solution by taking advantage of absorption effects of alumina, kaolin, lead phosphate, etc., followed by elution with very gentle chemical reagents. No less should the method of preparation of an inorganic catalyst aim at increasing as much as possible the efficiency of unit weight of the material. Prof. Willstätter gave examples of the use of the process of purification by adsorption in determining whether or not certain elements such as iron or phosphorus are essential constatuents of the enzymes. There is, however, no certain method of freeing the enzymes from protein derivatives. The tenacity with which proteins cling to enzymes threatens again and again to impose the conclusion that the enzymes are of a protein character. Invertase can, however, be freed almost completely from various chemically recognisable substances of high molecular weight without loss of activity or stability. The highest degrees of enzymic purity hitherto obtained have been achieved by a process of fractional adsorption on a finely divided precipitate, whereby an enzyme can be separated even from the products of its inactivation. In many cases there are indications as to which atomic groups of an enzyme are responsible for its union to an adsorbent, and delicate gradations in adsorptive power are determined by differences in the constitution of the particular gel employed. The only property of enzymes which is independent of their varying degree of purity is, apparently, their qualitative specificity. It is even possible, in certain cases, to ascertain the particular atomic group of the substrate molecule towards which the enzymic activity is directed.

In addition to the official welcome given to Prof. Willstätter by the Chemical Society, a number of members of the Athenæum, representing many branches of biological and chemical science, entertained him at dinner at that Club on May 17. Prof. H. E. Armstrong was in the chair, and by the kindness of the director of the Royal Botanic Gardens, Kew, the table was decorated with some of the flowers of which the pigments have been investigated by the guest of the evening. When, in 1913, Willstätter and Everest described their work on the pigment of the blue cornflower, which they called cyanin, they laid the foundation of the fuller investigation of the anthocyan pigments that has been developed so successfully since that date, with the result that the colouring matters of the rose, pelargonium, viola, peony, hollyhock, cherry, and many other flowers are now known. Prof. Armstrong made a felicitous reference to an extract from Walt Whitman's "Leaves of Grass" in proposing the toast of Prof. Willstätter at the dinner:

> "A Child said, 'What is Grass?' fetching it to me
> with full hands.
> How could I answer the child?
> I do not know what it is any more than he.
> I guess it must be the flag of my disposition, out of
> hopeful green stuff woven."

Prof. Willstätter was welcomed as the man who had so greatly helped to draft what must finally be the answer to the child's question, at least in respect to the mingled greens and yellows which make up the beauty of plant colours; and Prof. Armstrong expressed the hope that he would return to this field of inquiry and discover new secrets in it.

In a report from Cairo, Dr. Reisner states that at the moment of closing down-operations for the season, the Harvard-Boston Expedition has made another discovery of no little importance at Giza. While excavating the burial chamber of Queen Hetepheres discovered two years ago, the clearing of the Royal Necropolis eastward of the Great Pyramid has proceeded simultaneously, and here, on what was intended to be the last day of the season's work, a doorway in the rock was disclosed which proved to be the entrance to the tomb of Meresankh, a granddaughter of Khufu (Cheops) and great-granddaughter of Queen Hetepheres, wife of Seneferu. It appears that three halls of the funerary chapel have been discovered. Statues and statuettes stand in niches in the walls; but the special feature of the tomb is the decorations in relief and colour. Some of these were added after the original decoration, one being of a son of Neweserraankh, a king of the Fifth Dynasty who claimed royal descent from Queen Meresankh, possibly being her grandson. This gives six generations descended from Queen Hetepheres represented here, extending from the Third to the Fifth Dynasty. According to the account given in the *Times* of May 19, all the figures show the characteristic physique of the family of Cheops, a receding chin, stumpy build, and obesity. One outstanding feature of the report is that a representation in relief of Hetepheres, daughter of Khufu and mother of

Meresankh, has short yellow or red hair. This is the earliest representation of that variant of pigmentation among the dark-haired Egyptians, and opens up an interesting field of speculation as to racial admixture at this early date.

A memorandum on the inscription of Darius I. recently discovered at Hamadan has been submitted by Prof. E. Herzfeld to the Indian Archæological Department. The record, which was engraved in three languages, old Persian, Elamite, and Babylonian, on each of two tablets of gold and silver, fixes the limits of Darius's empire "from the Saka, who are beyond the Sugd as far as the Kush, from the Hindu as far as Sparda." According to an account in the *Times* of May 19, Prof. Herzfeld concludes that Darius added Hindu to his conquests in 516 B.C. More important than his determination of the date, however, is his identification of Hindu with the third Indian sculptured figure of Darius's tomb, the other two being Gandara and Thatagush. The location of the last named had not hitherto been determined, but it is now suggested that the specific mention of Hindu, that is, Sind (Persian H = Indian S), and Gandara occupying the Kabul River Valley, Swat and the country around Taxila, fixes Thatagush (Persian Satagus, Indian Satagav—"having a hundred head of cattle") as having inhabited the Punjab. The inscription has a further significance in its bearing upon early racial distributions, for in giving the location of Saka as beyond the Sugd, Prof. Herzfeld holds that it throws light on the home of the kindred tribes which occupied the country between the Danube and central India and founded the empire which extended from Seistan to Malwa in central India.

At an extraordinary meeting of the Council of the National Union of Scientific Workers, held at Caxton Hall, Westminster, on May 21, it was decided to change the name of the society to "The Association of Scientific Workers" in accordance with the votes cast by members and potential members for each of three titles, "The Association of Scientific Workers," "The Association of Scientists," "The Institute of Scientists." It was also decided, in order to give every qualified scientific worker in Great Britain the opportunity of becoming a member of the society, to make the subscription rate, as from Jan. 1, 1928, a minimum of ten shillings, leaving it to members to increase this amount according to their means. In view of the attitude of the Government towards professional organisations, as outlined by Mr. Ronald McNeill, the following resolution was put and passed unanimously: "That this Council Meeting of the Association of Scientific Workers calls on H.M. Government to amend Clause 5 of the Trade Disputes and Trade Union Bill in order to make it clear that civil servants in professional and technical grades are not deprived of the right to organise in their respective professional organisations, which have for their principal objects the maintenance of a high standard of professional attainment and the general improvement of status and conditions of servic among their members, by whatever authority employed, as well as the spread of scientific knowledg and the increase of public support for scientific work It reminds H.M. Government that H.M. Governmen has adopted the policy laid down in the Report o the Committee on State Servants that the professiona man in the Civil Service, unlike any member of th administrative or fighting services, should relate hi pay and position with those of his professiona brethren in the outside world, which implies that th professional civil servant should be organised with his brethren in outside occupations."

During the past few days, long-distance flights by aeroplane have been well to the fore. Nungesser and Coli set out on May 8 from Le Bourget, near Paris to cross the Atlantic, but at the time of writing, no news has been received of them. On May 20, two long-distance journeys commenced. Capt. Charles Lindbergh took off from Roosevelt Field, Long Island, New York, at 7·50 A.M. with the intention of making a non-stop flight to Paris; and Flight-Lieutenants C. R. Carr and L. E. M. Gillmans started at 10·42 A.M. from Cranwell Aerodrome, Lincolnshire, on a non-stop flight to India. Capt. Lindbergh landed at Le Bourget at 10·30 P.M. on May 22, having flown some 3500 miles in 33½ hours. His machine was a Ryan monoplane fitted with a 220 h.p. Wright "Whirlwind" engine and he carried 448 gallons of petrol. His course was along the American and Canadian coast to Newfoundland, across the Atlantic by a northerly route, along the south coast of Ireland, to Cornwall, Cherbourg, and Paris. Capt. Lindbergh was alone, and his feat was a noteworthy achievement of skill and endurance. Only once before has the Atlantic been crossed in one stage of flying and that was in 1919, when Alcock and Brown, flying a Vickers-Vimy machine, left the coast of Newfoundland at 4·28 G.M.T. on June 14 and landed at Clifden, Ireland, at 8.40 G.M.T. on June 15, having flown nearly 1900 miles. Lieuts. Carr and Gillman, on their attempt to reach India, flew a Hawker Horsley day bomber fitted with a 650-700 h.p. Rolls-Royce "Condor" engine, and carrying 1100 gallons of petrol. The total weight of the loaded machine was 14,200 lb., as against the 4750 lb. of Capt. Lindbergh's monoplane, which was of course specially designed for the Atlantic flight. Lieuts. Carr and Gillman came down in the Persian Gulf 45 miles south-east of Bandar Abbas at 8.15 P.M. on May 22. Both airmen were picked up by a passing vessel, but their machine was lost. They appear to have covered about 3500 miles in 30-32 hours.

On May 4 occurred the centenary of the death of Mark Beaufoy, F.R.S., who assisted to found the Society for the Improvement of Naval Architecture of 1791 and to whom we are indebted for a long series of experiments on the resistance of bodies moving through water. Beaufoy's experiments, described in his "Nautical Experiments," were carried out in the old Greenland Dock and extended over the years 1793–1798. It is said the experiments cost between £20,000 and £30,000 and that most of this was found by Beaufoy himself. The history of the Society and Beaufoy's work was the subject of a paper to the Institution of Naval Architects by Mr. A. W. Johns in 1910. Beaufoy was born in 1764, and was the son of a brewer. When twenty-three years of age he visited Switzerland and was the first Englishman to climb Mont Blanc, reaching the summit on Aug. 9, 1787, six days later than Saussure. In later life he turned his attention to magnetism and astronomy, and was one of the earliest members of the Royal Astronomical Society, to which his son afterwards presented his instruments.

The *Proceedings of the Cambridge Philosophical Society, Biological Sciences*, has changed its scope and, under the title of *Biological Reviews and Biological Proceedings of the Cambridge Philosophical Society*, will take the form of critical summaries of recent work in special branches of biological science. The contents of vol. 2, No. 2, give an excellent idea of the aims of the publication in its new guise. It contains three articles, the first of which, by M. Abeloos, deals with the theories of polarity in the phenomena of regeneration. After a review of recent work in this field, M. Abeloos concludes that Loeb's theory of formative substances, if apparently providing a satisfactory interpretation of the facts of regeneration in plants, is insufficient when applied to the animal kingdom. He is of the opinion that the theories of Child alone provide any approach to a complete explanation of the quantitative, qualitative, and physiological aspects of polarity. Dr. F. H. A. Marshall discusses the conditions governing parturition and recent investigations which seem to throw light upon the problem. He shows that parturition is not the result of one or two factors but of a combination of conditions all contributing to the end in question. These conditions are analysed in the light of recent research. In a brilliant review of the mechanics of vertebrate development, Dr. G. R. de Beer summarises the work which has been done and the results achieved in the experimental study of the early development of vertebrates. If this number can be taken as indicative of the aims and scope of the journal for the future, it can be stated at once that it will meet a long-felt want. The articles are comprehensive in character, critical in outlook, and masterly in treatment. Biological workers will welcome such authoritative summaries of current work, and university teachers, in particular, will be grateful for such valuable help in their struggles, often under the most adverse conditions, to keep pace with the bewildering multiplicity of developments in biology and the ever-increasing scope of the science. *Biological Reviews* deserves the support of all workers in this branch of science.

The annual report of the Institute of Physics for the year 1926, which was received and adopted at the annual general meeting held on May 16, refers to the changes which have been made in the honorary secretaryship and secretaryship of the Institute, already announced in our columns, consequent upon the resignation of Prof. A. W. Porter and the death of Mr. F. S. Spiers. The report shows a steady increase in the membership of the Institute, and refers to revised regulations for the admission of students which are intended to make the student membership more attractive to those who are not yet in a position to apply for corporate membership. Particulars are also given of the arrangements which are being made at the new offices of the Institute at 1 Lowther Gardens, Exhibition Road, South Kensington, London, S.W.7, whereby the Institute will undertake at the new offices, on behalf of the Physical and Optical Societies, routine work such as correspondence in relation to membership and subscriptions, and the control of stocks and sales of publications. The annual exhibition of the Physical and Optical Societies is included in this arrangement, and the exhibition will in future be organised from 1 Lowther Gardens, and controlled by a committee of representatives of the two societies, to which the secretary of the Institute will act as secretary. A fund for the furnishing and equipment of the offices has been raised largely on the initiative of Mr. Robert W. Paul, chairman of the Finance Committee, and generous contributions to this fund have been made by members of the Institute and by a number of firms. The editor of the *Journal of Scientific Instruments* reports the satisfactory progress of this publication, and announces that under the new editorial arrangements it is hoped to extend the manufacturing sections of the Journal.

The second of the conversaziones of the Royal Society this year will be held on June 22.

The Safety in Mines Research Station at Harpur Hill, Buxton, will be opened by Viscount Chelmsford, chairman of the Miners' Welfare Committee, on June 14.

Dr. Max Weber, emeritus professor of zoology in the University of Amsterdam, who is an authority on marine mammals and fish, and has for many years engaged in oceanographic work, has been awarded the Agassiz Medal by the U.S. National Academy of Sciences.

The following have been elected honorary members of the Russian Academy of Sciences: Prof. Albert Einstein (Berlin), Mme. Curie (Paris), Prof. W. Nernst (Berlin), Prof. A. A. Michelson (Chicago), and Prof. M. G. Mittag-Leffler (Djursholm, Sweden).

The tenth Silvanus Thompson memorial lecture of the Rontgen Society will be given at 8.30 on Tuesday, June 14, in the Barnes Hall of the Royal Society of Medicine, 1 Wimpole Street, W., by Sir J. J. Thomson. The subject will be "The Structure of the Atom and Radiation."

Dr. E. H. Rayner will deliver a lecture, to be followed by a discussion, on the solar eclipse of June 29 at a special meeting of the Physical Society, to be held on June 3 at 5 P.M., at the Imperial College of Science and Technology, South Kensington. Fellows of the Society are invited to take friends to the meeting.

AT the annual general meeting of the Manchester Literary and Philosophical Society, the following officers were elected: *President*, Prof. W. L. Bragg; *Vice-Presidents*, Dr. G. H. Carpenter, Dr. O. T. Jones, Dr. H. Levinstein, Dr. R. S. Willows; *Secretaries*, Mr. John Allan, Prof. E. A. Milne; *Treasurer*, Mr. R. H. Clayton; *Librarians*, Mr. C. L. Barnes, Dr. J. C. Withers; *Curator*, Mr. W. W. Haldane Gee.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant lecturer in agricultural chemistry at the East Anglian Institute of Agriculture, Chelmsford—The Clerk of the Essex County Council, Shire Hall, Chelmsford (June 4). A demonstrator in the department of organic chemistry of Bedford College for Women—The Secretary (June 8). A senior and a junior lecturer in comparative anatomy and embryology in the Natural History Department of the University of Edinburgh—The Secretary, The University, Edinburgh (June 10). A lecturer in chemistry in the University of Reading, preferably with physical chemistry qualifications—The Registrar (June 10). An assistant lecturer and tutor in social science at the London School of Economics and Political Science—The Secretary, London School of Economics and Political Science, Houghton Street, W.C.2 (June 15). An assistant lecturer in applied electricity at the University College of North Wales, Bangor—The Secretary and Registrar, University College of North Wales, Bangor (June 15). An assistant lecturer in mathematics in the University of Sheffield—The Registrar (June 15). A professor of pathology at St. Bartholomew's Hospital Medical College—The Academic Registrar, University of London, South Kensington, S.W.7 (June 20). A professor of agriculture and a lecturer in entomology and zoology at the Imperial College of Tropical Agriculture, St. Augustine, Trinidad—The Secretary, Imperial College of Tropical Agriculture, 14 Trinity Square, E.C.3 (June 29). A temporary research officer under the Foot-and-Mouth Disease Research Committee of the Ministry of Agriculture and Fisheries—The Secretary of the Committee, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1. A Secretary and bursar of the South-Eastern Agricultural College, Wye, Kent—The Principal. A research assistant at the Government Laboratory, Porton—The Commandant, Experimental Station, Porton, near Salisbury. Chemists in the establishment of the War Department Chemist, Woolwich—The Permanent Under-Secretary of State, War Office (F.6), London, S.W.1.

Our Astronomical Column.

THE COMING TOTAL SOLAR ECLIPSE.—As an example of the general interest in astronomy that is being awakened by the approaching eclipse, we may mention a pamphlet by Mr. A. J. Hawkes, Borough Librarian at Wigan, in which he gives a list of the astronomical books in that Library, together with particulars and a map of the eclipse track. The map seems to place Wigan too far from the zone of totality; it is placed five miles outside, but the map issued by the Ordnance Survey places it considerably closer. The author seems to be in error in saying that the eclipse of August 1999 will not be total in Cornwall; it is true that calculations have not yet been made using Brown's tables of the moon, but fairly trustworthy calculations indicate that the Lizard and several miles to the north of it will enjoy total eclipse.

The list of books on astronomy is grouped under 23 different headings and occupies 8 pages. It is to be hoped that it may lead to a revival of popular interest in astronomy, such as was awakened by the Norwegian totality of 1896.

NEW DETERMINATIONS OF THE VELOCITY OF LIGHT.—The velocity of light *in vacuo* is a constant of fundamental importance in modern science, and it is necessary that the utmost attainable accuracy should be aimed at in determining its value. Great interest, therefore, lies in the experiments started in 1924 by Dr. A. A. Michelson at Mt. Wilson, with the object of re-determining this important quantity. The method originally employed was to send a beam of light from an octagonal mirror at Mt. Wilson to a station 22 miles distant, whence it was reflected back (by a fixed mirror) to the first mirror, and finally into a micrometer eyepiece. The octagonal mirror was rotated at such a speed that it moved one-eighth of a turn during the journey of the beam of light to the distant station and back (44 miles). The returning beam was thus received on the succeeding facet of the rotating mirror at the same angle as if the latter were at rest. The velocity of rotation required gave, by a simple calculation, the velocity of light in air. This apparatus has been slightly modified and improved in the later series of observations made by Dr. Michelson. Rotating mirrors of various types are used, some of steel, others of glass, with eight, twelve, and sixteen facets; the results from the different mirrors being in excellent agreement. These latest experiments are described in the *Astrophysical Journal*, vol. 65, p. 1, in which the final value of the velocity of light *in vacuo* is given as 299,796 km./sec. The success so far attained has led to the consideration of an extended base line, and it is hoped to continue the work with a distant mirror on Mt. San Jacinto, 82 miles from Mt. Wilson.

ROYAL ASTRONOMICAL SOCIETY'S ANNUAL REPORT.—The annual report of the Council of the Royal Astronomical Society (*Monthly Notices*, Feb. 1927) contains the usual valuable summary of astronomical progress during the year. In particular a lengthy section by "H. D." on variable stars may be mentioned, which summarises all the important papers published on this subject during the year, and gives copious references. The fact that more than a third of this article is devoted to Cepheid Variables shows that the recent revival of interest in these objects is still being maintained. A valuable innovation has been introduced by "J. A. C." in the sections on solar research and stellar spectroscopy. This consists in a classified bibliography at the end of each section giving references to all relevant papers published during the year, including those not specifically mentioned in the text. This will be appreciated by those specially interested in solar and stellar physics, and is a procedure which might advantageously be extended to the other sections. In addition to the notes on astronomical progress, this issue contains obituary notices of deceased fellows, annual reports of observatories, and the presidential address of Dr. Jeans on the occasion of the award of the Society's Gold Medal to Prof. Schlesinger.

Research Items.

Maori Games.—A valuable monograph by Mr. lsdon Best on the games and pastimes of the Maori as been published under the direction of the Board of thnological Research of the Dominion Museum, N.Z., s Bulletin No. 8. Not only is the account of Maori ames given by early travellers meagre, but, owing o the disapproval of these games by the missionaries, otwithstanding their harmless character, few of them urvived until the beginning of the present century. ike other features of Maori life, the arts of amusement were attributed to a mythical originator. The practice of the arts of Ruhanui followed the rising of Whanui (the star Vega) when the main crops were lifted. The indulgence in games thus depended to ome extent on the leisure afforded by seasonal ccupations, but they were also played at night. he recreations may be classified into (1) children's ames played at all times; (2) games played at night or at free times when members of two or more amilies met in a house or on the village plaza; (3) at large meetings such as ceremonial feasts, arvest festivals, etc., when members of one or more ub-tribes gathered together, contests of skill or trength forming a special feature of the occasion; or (4) specially arranged contests between members of different village communities, in wrestling, canoe owing, dart throwing, posture dancing, and the like. ite-flying contests were also held. Certain of the ames, such as the duels and combats in the school or arms for men, and the posture dances for women, ere looked upon not merely as recreation but also s a training for the arts of life, the grace of action, or example, to be acquired through the dance being egarded as an essential in a girl's deportment. The onograph includes in its scope a careful and detailed tudy of the songs and musical instruments. The Maori did not use stringed instruments, but only ind and percussion.

Sugar Beet in England.—Mr. G. Turville Brown, n Paper No. 507 of the Surveyors' Institution, gives full account of the British sugar beet industry. eginning with a general history of the sugar industry, e shows that the introduction and development of beet sugar in Europe can be traced largely to olitical conditions, and that the chief reasons why t was not possible to establish its cultivation in ngland earlier were the facts that the bulk of the beet sugar exported from the Continent, a practice encouraged by European governments with bounties, came to Great Britain, and that British interests were largely vested in the production of cane sugar in the British Empire. The first attempt to introduce the cultivation of sugar beet into England in 1870 was unsuccessful, and even in 1921 the revived industry suffered heavy loss in spite of Government aid. The passing of the Beet Sugar Subsidy Act in 1925, however, details of which are appended to the paper, has resulted in the industry attaining national importance, and in the first year five of the ten factories showed a profit. Although in comparison with countries where the growers are experienced the tonnage obtained is low, the quality and sugar content have been high, and when the farmer has learnt to make the best use of the by-products, namely, the fodder portion of the crop, there is good augury for the success of the industry in Great Britain. With regard o the return which the farmer receives, an average figure based on the prices for 1925 and 1926 shows a £10 profit on a 10-ton crop, without including the feeding value of the residual tops and leaves. Further, any increase in the cultivation of a profitable root crop would help to check the modern tendency of putting arable land down to grass. As regards climate, England and the lowlands of Scotland are quite suitable for sugar beet, and indeed Great Britain, in being less liable to late frosts, has a distinct advantage over northern Europe. The importance of this is manifest, since much seed-selection work is being carried out in Holland with the view of securing a variety able to withstand late frost without going to seed. Some points with regard to the choice of suitable factory sites, and the methods of working which will secure the greatest possible economy, are included, matters which will prove themselves all the more important to the life of the industry as the subsidy decreases.

Age and Area.—In an article in the *Quarterly Review of Biology* (vol. 1, No. 4) Dr. J. C. Willis replies in part to various criticisms of the age and area hypothesis, and particularly to those of Prof. Fernald in the same journal (vol. 1, No. 2). Many points of difference are involved, some of which cannot at present be settled. For example, as regards rate of distribution, Willis estimates that the wing-fruited Dipterocarp trees of Malaya and the Philippines would be dispersed at the rate of 100 miles in 60,000 years, while Fernald points out that nearly the whole of Canada must have been forested from farther south since the retreat of the ice not more than 25,000 years ago. Notwithstanding the rapid dispersal of weeds, Willis concludes that generally whole associations of plants must advance together but with extreme slowness. Again, the need is recognised for distinguishing between local endemics and epibiotics or survivors from a larger area: and the fossil history, which often cannot be traced, must also be considered. Again, it appears that, *e.g.* in the Ericas of South Africa, a wide-ranging northern form has quickly produced a whole series of new local types after reaching what must be regarded as favourable conditions for the genus. Willis insists upon the necessity of treating his results statistically, but it appears unnecessary to make the improbable assumption that new species have generally arisen as the result of a single mutation. His work has brought fresh interest to the old problems of distribution; and further investigations should show in how far time, which no one denies is a factor in dispersal, can be disentangled statistically from the many other factors such as barriers, the rate and conditions of variation, etc., which will play a part in determining the area occupied by a particular species or group of species at a particular time.

Tortoiseshell Cats.—The tortoiseshell cat remains a genetic anomaly, although the work of Mrs. Bisbee and Miss Catherine Herdman (*Jour. Genetics*, vol. 18, No. 1) sheds further light on the subject. Normally tortoiseshells are females derived from a cross between yellow and black, but in rare cases a male tortoiseshell may occur. Numerous theories have been put forward to explain these and related facts. It appears that either there is a difference in the dominance of black and yellow in the two sexes or both colours are sex-linked. The authors favour the latter view, having found that all yellow cats of either sex have a few scattered black hairs. In the breeding experiments an anomalous yellow female appeared, which showed and transmitted a very small amount of black spotting. This is accounted for by a theory of fractionation of a factor—yellow; the 'anomalous yellow' and black being regarded as a series of multiple allelomorphs.

New Cotton Species.—Five new species of cotton have recently been described by Messrs. O. F. Cook and J. W. Hubbard, who give a general account of these primitive cottons in *Jour. of Heredity*, vol. 17, No. 12. They were found among desert vegetation or in door-yards and along roadsides in the provinces of Sonora and Sinaloa in north-western Mexico. One species, *Gossypium Morrilli*, found growing in natural undisturbed conditions in the Yaqui Valley, produces great numbers of bolls and has commercial possibilities. *G. contextum* has the interesting peculiarity that numerous additional fibres form a lining to the inner walls of the carpels, but it is not yet certain that they are actually attached to the wall. Another desert species, *G. davidsoni*, has no lint, but only a short brown fuzz on the seeds. The different types are well illustrated by photographs, and some of them will be useful for crossing with the cottons in cultivation.

Agriculture in Nigeria.—The fifth annual bulletin (1926) of the Nigerian Department of Agriculture contains the reports of the various agricultural stations for the previous year, together with a number of papers dealing in detail with some of the investigations in progress at the different centres. A scheme is proposed, which of necessity will extend over a long term of years, the object of which is to increase the production of palm fruit, but social and administrative considerations, arising largely from the manner of ownership of the groves, tend to increase the difficulties entailed in carrying out any improvements. The ground-nut trade is another important industry, but possesses many problems, which if solved would greatly enhance the value of the product. The best time for lifting the crop, and suitable preparation for export, such as efficient decorticating, grading, and packing, are some of the principal subjects under present consideration. An improved method for the extraction of palm oil by natives, the Cooker-Press process, is described and its advantages over the current methods pointed out. Research as to the most suitable preparation of palm nuts before cracking, and the subsequent treatment of the nuts and kernels affords another example of investigations which are likely to prove of immense help to the native industries. Variety trials, cultivation and manurial experiments of all kinds, are reported from the various agricultural stations, and fungoid diseases of cotton and, to a less extent, the control of insect pests such as the yam beetle, are being investigated.

Water and Industrial Development.—The relation between the quality of the water and manufacturing activity in the United States is discussed by Mr. W. D. Collins in Water Supply Paper 559 (United States Geological Survey). The supply of water is a factor of equal importance with raw materials, power, labour, and transport, in deciding the location and growth of manufactures, and though water can be artificially improved, the cost of so doing is generally too great in manufactures that require large quantities of water of definite quality. A comparison between the location of industries fifty years ago and the present time appears to show that soft water was then more important than it is now, since manufacturing activity has increased most rapidly in States which have hard water. However, Mr. Collins shows that the growth of industry in hard water regions is mainly of two kinds: first, industries that do not depend on the quality of the water, suc as metal and wood industries, canning and preservin glass and rubber works; and secondly, industries i which numbers of population are more importan than any other factor, as flour mills, confectioner printing, gas-making, etc. The industries dependen on the quality of water, which include chemica textiles, leather and paper, within the last fifty yea have grown almost entirely in those States where th water is soft or only slightly hard, and they do n show any tendency to shift from those regions. Th whole subject is treated statistically and illustrate with distribution maps.

Iron Ores in Western Canada.—Messrs. G. Young and W. L. Uglow have provided an account the iron ores in the western part of Canada in a recen memoir (Canada. Department of Mines; Geologic Survey. Economic Geology Series No. 3: Vol. British Columbia and Yukon. (No. 2093.) 40 cent Ottawa: F. A. Acland.) It must be admitted th from the economic point of view the report is not part cularly hopeful. There are 24 deposits listed believe to contain upwards of 25,000 tons of iron ore; th amount of ore considered to be almost certainl present is only 137,000 tons; the amount of o probably present is estimated at 1,200,000 tons an the total possible ore contents only 5,000,000 tons these figures refer to magnetite deposits, of which th greater part of the iron ore deposits in the area di cussed consist; with a couple of exceptions deposits rich in apatite, all the known magneti deposits are of Bessemer quality. There are also few deposits of limonite, but these do not appe to be of any great importance. Furthermore, th difficulties of transport in several cases are at prese very serious. The report considers that the mag netite deposits of the coast districts must be look upon as the primary sources of native iron ore th might support an iron-making industry in Briti Columbia, but evidently the prospects of such industry being formed on an economic basis do n at present appear to be very promising.

The Origin of Meteorites.—In *Gerlands Beiträ z. Geophysik* (1927, pp. 195-222), R. Schwinner di cusses the origin of meteorites in greater detail tha has hitherto been attempted. He suggests th meteorites cannot be descendants from any part our solar system, but that they form a cosmic clou which the solar system entered for the first time i early Quaternary time. This deduction is base partly on the orbits of meteorites and partly on th remarkable fact that no meteorites from beds Tertiary or older formations have ever been discovere The origin of the cosmic cloud is ascribed to a collisi between two small stars which is estimated to hav occurred between 10^{10} and 10^{11} years ago. It claimed that the structure of meteorites supports th view that they were formed like explosive tuffs an that some parts of them cooled rapidly in a wea gravity field. Though meteorites as a whole ma provide a kind of cross-section through a former existing heavenly body, the supposition that th provide any information as to the interior of the ear must be regarded with extreme caution. As to th origin of tektites, the author is unable to deci whether or not they are of meteoric origin.

Fractional Precipitation of Barium an Radium Chromates.—Several methods are ava able for the separation of radium and barium fractional precipitation. In the *Journal of t American Chemical Society* for March, Henderson an racek describe a method of separation by means of he chromates which compares very favourably with he best of those previously employed. In general, he radium-barium solutions were treated with ydrochloric acid followed by definite quantities of otassium chromate solution. Partial separation llows from the fact that barium chromate is ppreciably more soluble than the corresponding adium salt. This method may be used with dvantage when the radium content of such mixtures too small to be treated by the chloride method.

CHEMICAL TREATMENT OF FLOUR.—We have eceived a copy of the Report of the Departmental ommittee which has been considering the treatment f flour with chemical substances, published by H.M. tationery Office (6*d.* net). Chemical substances are ntroduced into flour in the first case as bleaching gents, and secondly as improvers, which are said to nhance the natural baking qualities of the flour, which may be deficient in one or more respects. mong these substances are calcium and ammonium cid phosphates, persulphates, chlorine, nitrogen richloride, nitrogen peroxide, nitrites, and benzoyl eroxide. The Report recommends that when bleaching and improving are necessary the use of chlorine, itrogen trichloride, and benzoyl peroxide should be voided. An alternative method of improving by hysical means is suggested. By heating wheat or lour at a given temperature for some time, the baking roperties are considerably improved, and under ertain conditions this flour itself may be used as an mprover. At least one mill has discontinued the se of chemical improvers in favour of the physical nethod.

THERMAL DISSOCIATION OF IODINE AND BROMINE.—The method usually employed for the measurement f the dissociation of iodine and bromine, namely, by neasuring the pressure produced by a known amount f halogen sealed in a quartz bulb of known capacity n the presence of an inert gas, has yielded values which are in poor agreement with those predicted by heory. In order to establish with greater certainty he values of the thermal quantities involved, Devries nd Rodebush have adapted the method of Knudsen or the determination of vapour pressure by the neasurement of the rate of diffusion through a small rifice. Their work is described in detail in the *Journal of the American Chemical Society* for Mar. 1927. The previously accepted value for the entropy f monatomic iodine at 298° K. and 1 atmosphere is 12·6, while the calculated entropy is 40·4. Although the newly determined number is 40·5, Devries and Rodebush consider that the true value of the entropy ies between 42·6 and 40·5, since spectroscopic data indicate that the iodine molecule should possess a magnetic moment and consequently a higher entropy. The calculated entropy of monatomic bromine is 39·0, but this is only approximate, and for this reason no significance can be attached to the agreement of this value with that of 38·2 determined experimentally.

ATOMIC PHYSICS.—The issue of the *Physikalische Zeitschrift* for Mar. 15 contains an address on the present position of atomic physics, delivered by Prof. A. Sommerfeld before the Faculty of Science at Hamburg. One of its objects was to counteract the pessimistic opinion held by many, of the inability of the quantum theories to give a comprehensive view of the physics of matter capable of replacing entirely the electromagnetic theory of thirty years ago. While Heisenberg introduces into his specifications of atomic systems only such quantities as can be directly observed, Schrodinger and de Broglie in their wave mechanics go behind observed phenomena, and their method has led to great developments in the mathematical treatment of atomic problems. Unfortunately, the new mechanics destroys the sharpness of the picture of the planetary atom to which we have grown accustomed, but the gain in mathematical simplicity is of much greater importance than this loss, and there can be no suggestion of entirely giving up the Bohr theory of the atom.

COMPRESSIBILITY OF HYDROGEN AND NITROGEN.—In view of the number of processes now in use for the production of ammonia from mixtures of hydrogen and nitrogen at pressures from 100 to 1000 atmospheres, data concerning the properties of the compressed gases are of great value. The compressibility isotherms of hydrogen and nitrogen and mixtures of these gases at 0° and pressures up to 1000 atmospheres have been determined at the Fixed Nitrogen Research Laboratory of the American Bureau of Soils by E. P. Bartlett. A quantity of gas at a given pressure and temperature, confined in a heavy steel pipette of known volume, is allowed to expand into a gas burette, and the amount of gas determined by measurement of a fixed volume at a known pressure differing but slightly from atmospheric. Details and the results of this work are given in the *Journal of the American Chemical Society*, Mar. 1927. The compressibility factor of a mixture cannot be calculated from those of the separate gases, since the compressibilities are not linear functions of the composition, but certain empirical equations have been derived connecting these two quantities.

AN ALUMINIUM FILM FILTER IN TELEPHONY.—In a modern telephone system there is a battery of accumulators at the central office which serves as a common reservoir of energy for talking and signalling. It is necessary to charge this battery while it is connected to the system. The alternating components of voice frequency in the output of the charging generator appear as objectionable noise currents in the telephone lines, and therefore great pains are taken to design the direct current generator so as to eliminate all ripples from the voltage wave. This more than doubles the cost of the machines, reduces their efficiency and increases the maintenance cost. In the *Bell Laboratories Record* for April, Mr. Siegmund describes a filtering device which prevents the disturbing ripples from entering the talking circuit even when only a cheap commercial dynamo is used for charging. As condensers having capacities of several thousand microfarads have to be employed, the device would not be economical were it not for the high capacities and the little space occupied by aluminium electrolytic condensers. When an aluminium rod is maintained positive to a suitable electrolyte, a very thin non-conducting film is formed on it which forms the dielectric of the condenser. The electrolytic condenser resembles a single-cell storage battery. The anode plate is corrugated and the cathode plate is flat. They are fastened to the porcelain cover of the jar. For 24-volt operation one jar has a capacity of about 1000 microfarads. They require no routine maintenance. The oscillograph records shown by Mr. Siegmund prove the utility of the device. The properties of the aluminium film have been already used in chemical rectifiers, in lightning arresters and in condensers for power work. Their application in telephony, however, is of particular value at the present time, when the power required for machine switching in automatic systems is growing so rapidly.

What Determines the Resistance and the Tilt of an Aeroplane?[1]

By Sir JOSEPH LARMOR, F.R.S.

ONE used to recognise that the exigencies of flight in the tenuous air prescribed a limit to the bulk of a bird, as compared for example with a whale. Yet nowadays every day loads of twenty tons of stuff or possibly far more are carried over long journeys, owing to the power available, solely on wings. How does the attenuated aerial medium find means of supporting such an astonishing mass? To experts the fact is familiar, and so scarcely demands explanation. Indeed, the source of the support in plain terms is just as wonderful as the fact itself. The load is held up solely by the swirl that it produces and leaves behind, and this vertical support must be the only dynamical effect of the swirl when the speed is steady: there remains the question how precisely this result is adjusted. Unfortunately the wakes from screw and wings can scarcely be additive without some mutual interference, though momenta are additive always. For example the spread of the wings is adapted readily to counteract the rotational grip of the screw. Stability is theoretically (G. H. Bryan) another affair.

Whether the supporting medium is air, or water, or even pitch, provided only it is of uniform density everywhere, the momentum, with which the flight is concerned, proves to be expressible at each instant in terms of the distribution of swirl or vorticity alone. Force is experienced by the travelling system equal and opposite to the rate at which momentum is shed away into the wake of its motion. The nature of the swirl passing into the wake thus determines all. In the ideal perfect fluid of abstract hydrodynamics there would be no wake, and therefore no force affecting the translatory motion, though the mass may twirl in permanent precessional spin. If this train of ideas is right it is impossible for a circulation round the wing of an aeroplane to sustain it, except in so far as it ha to be associated with a vortical wake.

The formula for the momentum associated wit each element of whirl in the ambient medium, o whatever kind it be and however complex its interna friction, provided only it is *of uniform density*, turn out to be unexpectedly simple. There is translationa momentum equal, as applied at any chosen origin, t the vector moment of the mass-vorticity of the elemen (mass multiplied by spin), combined with rotationa momentum around that origin equal to this mass vorticity multiplied by the square of the distance wit sign reversed. Now vorticity has the advantage o being a quality of considerable persistence, unless th internal friction is high: if then this field of spin coul be sufficiently explored by observation, it would onl be necessary, in order to obtain the forces operating to trace out the rate at which the derived syste of momentum thus associated with the travellin machine is changing. Many special illustrations present themselves. For example, a travelling aeroplan adjusts its presentation so that this moment of momentum, with regard to the point where the pull of th screw intersects the line of weight, is not subject t loss into the wake: such automatic adjustment woul tend to nip together the two boundary sheets of th vortical trail, which thus would open out only at th ends of the wings. Again, a windmill parachut appears to be more effective than the simple umbrella type: if so, the cause doubtless declares itself in a wind-channel by the contrasted types of whirl in th wakes they leave behind. And generally, the performance of any propelling screw wholly submerged would be determinable in terms of the whirl in its wake alone, if only that could be explored.

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[1] Abstracted, with additions, from *Proc. Cambridge Phil. Soc.*, Feb. 1, 1927, pp. 617-630.

The Wren-Ashmole-Plot Memorial Windows at Oxford.

THE public unveiling of the memorial windows to Sir Christopher Wren, Ashmole, and Dr. Plot by the Chancellor of the University, Lord Cave, took place at Oxford on May 17 in ideal circumstances of weather, after the ceremony of the presentation of honorary degrees to MM. Doumergue and Briand. Speeches were delivered in the Divinity School by the representatives of the bodies who have given the windows. Mr. Madan, on behalf of Brasenose College, spoke on Ashmole as the founder of the oldest museum of natural history; Mr. Guy Dawber, president of the Royal Institute of British Architects, pronounced an éloge on Wren; and the Public Orator, Mr. Poynton, representing University, Magdalen, and Hertford Colleges, made a witty speech on Dr. Plot. The windows are a notable addition to the beauty of the staircase of the Old Ashmolean Museum, and will recall to generations of visitors the great pioneer work of this interesting group of men of science of the seventeenth century, some of whose work is illustrated in the Lewis Evans Collection on the upper floor of the building. The Chancellor expressed the grateful thanks of the University to the respective donors. He also paid a well-deserved tribute to Dr. R. T. Gunther, the Curator of the Lewis Evans Collection of Scientific Instruments, to whose zeal and energy are to be attributed the excellent arrangement and appropriate housing of the Lewis Evans Collection, and at whose instigation the donors of the memorial windows were moved to undertake these admirable additions to the interest of the historic building that contains them.

The new windows in the Old Ashmolean Building commemorate the work of Ashmole and his three friends, whose collective scientific achievements during the second half of the seventeenth century have proved second to none even in that fertile period of English science. The word collective is used designedly, for it is extremely probable that the labour or good intention of any one member of the group would have been of no avail without the faithful co-operation of the others. They have one and all in their several ways participated in the establishment in Oxford of the first public museum of natural history in Britain. It is meet that so great a public service should be recognised in the building, which fortunately is still standing, a monument to their great work.

The oldest member of the group, John Tradescant, was a great collector, a scientific traveller, a pioneer who introduced new plants into Europe, and followed his father as the owner of the first London museum, at Lambeth. To him succeeded Elias Ashmole, a great transmitter. He realised the supreme educational value of the collection, and on the death of Tradescant, saved it from being scattered by his widow. His social prestige assured its appreciative acceptance by the University, which received the gift with royalty and a banquet, after the expending of a great sum on a building which is not only the finest classical building in Oxford, but preserves to us Wren's plan for a scientific institution.

With singular appropriateness Oxford is therefore able to accept this memorial window to one of her most distinguished sons of science from the Royal Institute of British Architects. For long before the chance of rebuilding London definitely turned the scientific worker into the architect, Wren had filled the highest scientific post in the University with laudable distinction, and when the Ashmolean Museum was in building he occupied the presidential chair of the Royal Society.

The Tradescant window was presented by the Garden Clubs of Virginia in memory of his great prestige as a gardener and of his fruitful visits to their colony. It was unveiled by Lord Fairfax of Cameron in November last. The Ashmole window is given by the principal and fellows of Brasenose College, of which Ashmole was a member during his sojourn in Oxford. The badge and supporters to the coat of arms, the head of Mercury and the figures of the constellation of the Twins, are emblematic of Ashmole's double interest in astrology and alchemy, with especial regard to Mercury, planet and chemical element. The design has been taken from one of his most treasured books now in the Bodleian Library.

The inscription runs :

ELIAE ASHMOLE
HUIUS MUSEI FUNDATORI
COLL. AEN. NAS. PRINCIPALIS ET SOCII
ALUMNO SUO HANC FENESTRAM DEDICAVERUNT
MCMXXV.

The right-hand upper light records the distinguished service of Ashmole's first Keeper of the Museum, Dr. Robert Plot, one of the most remarkable of the Oxford celebrities of his time. He received his early education at University College, whence he proceeded to Magdalen Hall, and when thirty-seven years of age published his "Natural History of Oxfordshire," the work which not only made him famous but also probably suggested Oxford as the best destination for the Tradescant-Ashmole collections. His "Natural History" certainly was the first of its kind, and became the model for many later works. On the strength of a testimonial from John Evelyn, Ashmole in 1683 appointed Plot as his first Keeper of the Museum, a position that he filled for seven years, combining the duties with those of professor of chemistry and of secretary to the Philosophical Society of Oxford.

Towards the end of his life, Plot, elected to the office of Mowbray Herald, seems to have adopted the coat of arms in the new window. The surrounding wreath is of two Oxfordshire flowers which Plot was the first to recognise as new to the British flora. They are the marsh violet (*Viola palustris*) and the "Greatest Dove's foot Crane's-bill with dissected leaves" (*Geranium dissectum*). The happy dedicatory inscription runs :

ROBERTUS PLOT R.S.S.
HUNC CELEBRANT COLLEGIA NOMEN ET ARTEM
TRADITA MUSEI EST PRIMO CUSTODIA PRIMI.

In the right-hand lower light are emblazoned the arms and crest of Sir Christopher Wren, with two swags of foliage and contemporary scientific instruments familiar to astronomers and navigators at the time when, as Savilian professor of astronomy, Wren doubtless taught their theory to his pupils. The instruments comprise the mariner's astrolabe, cross-staff, backstaff, astronomical ring dial, and nocturnal, all very carefully studied and drawn upon the glass. Of special interest is the drawing of Wren's own pair of compasses, now in the possession of the Royal Society, and the only example of his many instruments that has come down to us. A cartouche below contains the dedicatory inscription recording the circumstances of the presentation of this window by the Royal Institute of British Architects.

CHRISTOPHERUM WREN
ASTRONOMIAE PROFESSOREM SAVILLIANUM
COELESTIBUS EXSTRUCTIONIBUS NOBILEM COMMEMORAVIT
REGALIS SOCIETAS ARCHITECTORUM·BRITANNICORUM
MCMXXVII

In a letter to the *Times* for May 23, the anniversary of Ashmole's birthday, Mr. E. B. Knobel expresses the hope that these armorial windows may be supplemented by one to Dr. Lewis Evans, whose gift has led to the revival of the Old Ashmolean.

University and Educational Intelligence.

CAMBRIDGE.—Dr. G. F. C. Searle, Peterhouse, has been reappointed University lecturer in experimental physics, and Mr. C. Warburton, Christ's College, has been reappointed demonstrator in medical entomology.

LONDON.—At a meeting of the Senate on May 18, the Vice-Chancellor stated that with reference to the anonymous offer, already announced, of £10,000 towards the establishment of a chair of dietetics, Messrs. A. Wander, Ltd., had now intimated their desire to contribute a similar sum to the same object.

It was announced that a donor who desires to remain anonymous has offered £250 as a contribution towards any preliminary expenses involved in the preparation of a comprehensive plan for the development of the Bloomsbury site.

Mr. D. MacC. Blair, lecturer in regional anatomy in the University of Glasgow, has been appointed as from Aug. 1 to the University chair of anatomy tenable at King's College.

Dr. G. S. Wilson has been appointed as from Oct. 1 to the University readership in bacteriology and immunology tenable at the London School of Hygiene and Tropical Medicine. Dr. Wilson was educated at Epsom College, King's College, London, and Charing Cross Hospital. In 1919 he was appointed specialist in bacteriology at the Royal Army Medical College; in 1921 he became assistant in bacteriology under the Medical Research Council. In 1923 was appointed lecturer in bacteriology in the University of Manchester, and since 1925 he has been assistant director of the Public Health Laboratory, Manchester.

The following doctorates were conferred: D.Sc. in Botany on Mr. P. Sarbadhikari (Imperial College—Royal College of Science) for a thesis entitled "Cytology of Osmunda and Doodia—On the Gametophyte and Post-meiotic Mitoses of the Gametophytic Tissue of Doodia;" and D.Sc. (Economics) on Mr. G. C. W. C. Wheeler (London School of Economics) for a thesis entitled "Mono-Alu Folklore."

The Dunn Exhibitions in anatomy and physiology were awarded to Mr. K. M. Robertson, of St. Thomas's Hospital Medical School.

THE Society for the Advancement of the Training of Mechanics, Leyden, announces vacation courses for mechanics and glassblowers in August next at the Physical (Cryogenic) Laboratory of the University of Leyden. Full particulars can be obtained from Dr. C. A. Crommelin, the Physical Laboratory, Leyden, Holland.

BY the will of Lady (Charles) Henry, of Carlton Gardens, London, S.W., a large sum of money will become available for the foundation of scholarships at Oxford and Cambridge for American students and at Harvard and Yale for British students. The scholarships will be open to both sexes and are to be available for undergraduate as well as post-graduate courses. The Charles and Julia Henry Fund, as it will be termed, is to be administered by twelve trustees, three each being appointed by the four universities concerned, who will have wide discretionary powers. The whole of the residuary estate, estimated at £300,000, goes to the fund.

Particulars of vacation courses in England and Wales, 1927, are given in a pamphlet (London, H.M. Stationery Office. 6*d.*) issued by the Board of Education. Courses for teachers have been arranged by the Board itself, to be held at Oxford, Cambridge, London, Durham, Birmingham, Nottingham, Bangor, Brighton, Eastbourne, and Studley; by the local education authorities of Brighton, Carmarthen, Cheshire, Glamorgan, Hertford, Kent, and Yorkshire (West Riding); and by five teacher-training institutions. Courses for foreigners are offered by the Universities of London and Cambridge. The University Extension summer meeting will be at Oxford, and there will be the usual university tutorial class summer schools in connexion with all the universities except Reading. Among the various courses offered at Bingley by the West Riding County Council is one by Mr. Stanley Jast on the library and the school. The National Museum of Wales is giving a course on methods of caring for exhibits. Some thirty courses in their special subjects are offered by various voluntary associations. Summer Schools of the League of Nations Union are to be held at Oxford (St. Hugh's College, July 27-Aug. 5) and Geneva (Geneva Institute of International Relations: elementary, July 30-Aug. 5; advanced, Aug. 6-Aug. 12). At Oxford, Lord Hugh Cecil will give the inaugural address, and there will be a preliminary conference of teachers on July 27-29, opened by the Right Hon. H. A. L. Fisher.

Appointments made by the Committee of Award for the Commonwealth Fund Fellowships to the twenty Fellowships tenable by British graduates in American universities for the two years beginning in September 1927 include the following: Mr. J. M. Alston (Edinburgh), to Harvard University, in medicine; Mr. Maurice Black (Trinity College, Cambridge), to Princeton University, in geology; Mr. G. F. Brett (Leeds), to the University of Michigan, in physics; Mr. David Graham (Queen's University, Belfast), to the Massachusetts Institute of Technology, in electrical engineering; Mr. F. T. Hewer (Bristol), to Johns Hopkins University, in medicine; Mr. M. I. Hutton (Glasgow University and Balliol College, Oxford), to Yale University, in economics; Mr. Eric F. Nash (University College, Oxford), to Harvard University, in economics; Mr. R. A. C. Oliver (Edinburgh), to Stanford University, in education; Mr. A. Oppenheim (Balliol College, Oxford), to the University of Chicago, in mathematics; Mr. R. Robinson (Birmingham), to the University of Pennsylvania, in physical chemistry; Miss E. Simkins (Liverpool), to Clark University, in geography. This year the Commonwealth Fund has established three extra fellowships, primarily intended for candidates from British Dominions who have studied at British Universities. Nominations to these Fellowships include the following: Mr. H. I. Coombs (Adelaide University, Magdalen College, Oxford, and Trinity College, Cambridge), to the Rockefeller Institute, New York, in physiology; Mr. Reginald Jackson (University of South Africa and Trinity College, Oxford), to Harvard University, in philosophy.

Calendar of Discovery and Invention.

May 29, 1453.—From some points of view the fall of Constantinople, which took place on May 29, 1453, may be regarded as contributing directly to the birth of the modern age of scientific inquiry and discovery. When, after a siege of 53 days, Mahomet II. gained possession of the city, many Greeks fled into Europe, carrying with them the precious manuscripts of ancient Greek authors. Included in these were mathematical works which were translated and soon afterwards made available through the invention of the printing press.

May 29, 1624.—The first legislative enactment for regulating the granting of industrial monopolies was The Statute of Monopolies (21 Jac. I. c. 3) passed by the English Parliament on May 29, 1624. The Statute was not, as has often been assumed, the foundation of the English patent law; it merely gave parliamentary sanction to principles, already accepted at common law, which now form the basis of all patent laws throughout the world. Its purpose was to prevent the Crown from granting oppressive monopolies, but in the famous section 6 it exempted from the general prohibition the granting of patents for the encouragement of new inventions. This section is still in force.

May 31, 1836.—The introduction of screw propulsion was due to many pioneers, of whom, however, the foremost was Francis Pettit Smith. Smith's first patent was taken out on May 31, 1836, and he described his invention "to consist of a sort of screw or worm made to revolve rapidly under water, in a recess or open space formed in that part of the after part of the vessel, called the dead wood or dead wood of the run." His screw was tried successfully in the s.s. *Archimedes*, the first screw vessel to navigate the open seas.

May 31, 1919.—On the afternoon of May 31, 1919, the American seaplane NC4, piloted by Lieutenant-Commander A. C. Read, arrived in England, having since May 16 flown in three stages from New York to the Azores, thence to Lisbon and to Plymouth. She was the first machine to fly across the Atlantic.

June 1, 1785.—Cavendish in his study of the atmosphere used many methods, and some of these he described to the Royal Society in his paper, "Electric Discharges through Air," read on June 1, 1785.

June 1, 1894.—One of the landmarks in the early history of radio signalling was Sir Oliver Lodge's lecture at the Royal Institution on June 1, 1894, on "The Work of Hertz," when, with the aid of a Branly's coherer of filings, signals were detected at a distance from the transmitting apparatus.

June 1, 1906.—Five tunnels pierce the Alps—the Mont Cenis, the St. Gothard, the Arlburg, the Lotschberg, and the Simplon. Of these the Simplon is the longest and deepest, being 12¼ miles long and more than 7000 feet below the surface. Begun in 1898, it was opened on June 1, 1906. It was bored simultaneously from both ends, and when the two tunnels met, the error of alignment was only 3¾ inches.

June 2, 1881.—The famous test of Pasteur's views on the efficacy of vaccination of animals for anthrax culminated on June 2, 1881, at the farmyard of Pouilly le Fort. Twenty-five vaccinated and twenty-five unvaccinated sheep had previously been inoculated with some very virulent cultures of the anthrax bacillus. On June 2, Pasteur and others visited the farm. "The carcases of twenty-two unvaccinated sheep were lying side by side; two others were breathing their last. . . . All the vaccinated sheep were in perfect health. . . . The one remaining unvaccinated sheep died that same night."

E. C. S.

Societies and Academies.

LONDON.

Royal Society, May 19.—**Lord Rayleigh**: Studies of the mercury band spectrum of long duration. The stream of vapour is excited by a current of less than a milliampere, using a hot cathode. It is then observed spectroscopically after leaving the region of discharge. As in previous investigations, the resonance line λ2537 is associated with the band spectrum, but the resonance line λ1850 is absent. The important divisions of the band spectrum are: (*a*) The band at λ2345, with attendant bands of shorter wave-length; (*b*) the resonance line λ2537, with bands within a few Ångströms of it; (*c*) the fainter maximum at λ2650, and a series of flutings which are made out with difficulty but seem to be associated with it; (*d*) the broad maximum at λ3300; (*e*) the broad visual maximum. When the vapour is examined *after excitation* all these features decay *pari passu*. The actual time taken to decay to half intensity under the conditions is $1 \cdot 82 \times 10^{-3}$ second. If the excited stream of vapour is passed through a tube locally heated to redness, the band (*e*) is extinguished, (*a*) and (*c*) are slightly weakened, but (*b*) and (*d*) are almost unaffected. As the vapour passes on to the cold part of the tube the visual light (*e*) reappears to some extent, and (*a*) and (*c*) tend to regain their intensities relative to (*b*) and (*d*).

A. Fowler and **L. J. Freeman**: The spectrum of ionised nitrogen (N II). Observations have been made over the range λ6836 to λ830. Of 340 lines recorded in this region, about one-half have now been classified, and of the remaining lines more than 100 are very faint. The spectrum is built up from triplet and singlet terms. The scheme of terms deduced from the Heisenberg-Hund theory of complex spectra has greatly facilitated the analysis of the spectrum. Of the 19 deepest terms predicted for transitions of a single electron, complex terms being counted as one, all but one have been identified. The term 1^3P_0 recently identified by Bowen from a multiplet at λ671 is probably the deepest, its value being 238850, corresponding to an ionisation potential of 29·5 volts. A few multiplets which appear in the spectrum are attributed to double electron transitions.

O. W. Richardson: The hydrogen band spectrum: new band systems in the violet. This paper describes the *Q* branches of some band systems which include much of the strength of the secondary hydrogen spectrum when this is excited by direct electron impact on the H_2 molecule and there are no additional complications. The final states of the bands appear to be the same as the initial states of the Lyman bands in the far ultra-violet (the *B* states of Dieke and Hopfield). All the bands are degraded towards the violet. The strongest band system, denoted by *A*, has its nucleus ($0 \rightarrow 0Q$ (1) line) at λ4633·95(9). The *Q* branch of the $1 \rightarrow 0$ band is the series 20 *Q* (*m*) of Richardson and Tanaka. There is a less strongly developed band system (*B*) with its nucleus at 3684·38(2) and a few *Q*(1) lines of a system (*C*) with its nucleus at 3368·47(0). *A*, *B*, and *C* all have the same set of final states. The terms are $2S = 33727 \cdot 12$, $3P = 12676 \cdot 47$, $4P = 7087 \cdot 66$, $5P = 4514 \cdot 14$. They are very close and similar to the corresponding terms of the principal series of He *singlets* but rather larger.

O. W. Richardson: Note on a connexion between the visible and ultra-violet bands of hydrogen. There is evidence in the visible secondary hydrogen spectrum of the existence of bands the final states of which are the same as the initial states of the bands found by Werner in the Lyman region. Some of the consequences of this are discussed, including a recalculation of the moment of inertia of the normal hydrogen molecule. The value found is $4 \cdot 5 \times 10^{-41}$ gm. cm.^{2}

C. N. Hinshelwood and **P. J. Askey**: Homogeneous reactions involving complex molecules. The kinetics of the decomposition of gaseous dimethyl ether. In the decomposition of dimethyl ether to form carbon monoxide and hydrogen the reaction is unimolecular at pressures above about 400 mm. At lower pressures it ceases to be independent of the initial pressure. The hydrogen seems to act only by maintaining the Maxwell distribution among the molecules of ether, when this would otherwise be disturbed by the chemical transformation of activated molecules; for it can only restore the rate of reaction to its normal limiting value and cannot increase it beyond this. Nitrogen, helium, carbon monoxide, and carbon dioxide do not have a similar influence.

W. G. Palmer: An experimental test of the dipole theory of adsorption. The electric coherer functions normally when the loose contact is immersed in liquids, and the cohering voltage increases regularly in the homologous series of primary alcohols, fatty acids, and their ethyl esters, according to the rule $E^2/l = \text{constant}$, where l is the length of the chain. This result indicates that the energy of desorption in a given series is proportional to the square of the electric moment of the adsorbed molecule, and supports the dipole theory of adsorption.

Sir Robert Hadfield: Thermal changes in iron-manganese alloys low in carbon. The temperature at which the final recovery of magnetism occurs on cooling, with its accompanying evolutions of heat, is progressively lowered with increasing manganese percentage. The transformation, however, [redacted] gradually weaker in intensity and finally while still at a temperature of about 100° C., and at a manganese percentage just short of that at which non-magnetic qualities are reached, namely, 16 per cent. Thus the explanation that the alloys exceeding this percentage owe their non-magnetic qualities to their critical change points being below atmospheric temperature, is not tenable. The present work gives further support to the belief that the suppression of the magnetic qualities of the iron may be due to its actual combination with the manganese.

K. S. Krishnan and **C. V. Raman**: The magnetic anisotropy of crystalline nitrates and carbonates: Crystals of sodium and potassium nitrates exhibit a marked diamagnetic anisotropy, the susceptibility perpendicular to the plane of the NO_3-ion being greater than for directions in the plane; the difference of susceptibility in the two directions is the same for the two crystals. Attributing this anisotropy to that of the NO_3-ion, its magnitude is exactly what we should expect from the known value of the magnetic birefringence (Cotton-Mouton effect) of nitric acid liquid. An explanation is suggested on the basis of its electronic structure; the CO_3-ion, which has essentially the same structure, gives almost the same anisotropy.

C. G. Darwin: The Zeeman effect and spherical harmonics. The problem of a spinning electrified sphere moving in a central orbit in a magnetic field is solved in spherical harmonics by the method of the wave mechanics. It leads to a set of simple arithmetical equations which give exactly all the features of the standard Zeeman effect in all strengths of field. Strictly the model only yields the odd multiplicities, but the same system of equations is just as competent to give the even.

D. Jack: The band spectrum of water vapour. Evidence on the nature of the emitter of the water vapour bands is in favour of the OH ion. The band

2608 is similar in structure to the others and leads to the same final moment of inertia as the bands 3064 and 2811. The scheme of bands suggested by Dieke has been extended, and verified by taking differences of the wave numbers of corresponding lines in the various bands.

L. S. Ornstein, H. C. Burger, J. Taylor, and W. Clarkson: The Brownian movement of a galvanometer coil and the influence of the temperature of the outer circuit. A particular form of theory suitable to the requirements for the more complicated case of a galvanometer having an external inductance L, of ohmic resistance r, at an absolute temperature T°, is developed.

W. A. Bone and D. M. Newitt: Gaseous combustion at high pressures (Part vii.). A spectrographic investigation of the ultra-violet radiation from carbonic oxide—oxygen (or air) explosions. The resultant ultra-violet radiation from $2CO + O_2 + 4R$ explosions at corresponding high initial pressures, where R is a diatomic diluent, is much less when the latter is carbon monoxide or nitrogen than when it is oxygen; this result indicates that the former strongly absorbs the ultra-violet radiation emitted by the burning carbon monoxide in such circumstances. The marked nitric oxide formation which always occurs in a carbon monoxide excess-air explosion at an initial pressure of 25 atmospheres does not take place during the actual combustion, but after all the resulting radiation capable of effecting a sensitive photographic plate has been emitted. When nitric oxide is present during the actual combustion period in such an explosion, a definite absorption band spectrum is superposed upon the characteristic continuous ultra-violet spectrum of [illegible] burning carbon monoxide. The resultant ultra-[illegible]diation from a $2CO + O_2 + 4Ar$ explosion at an initial pressure of 14 atmospheres is very much stronger than that for a $2CO + O_2 + 4He$ explosion at [illegible] same pressure, although the maximum tem-[illegible]res attained in the two cases differ by 130° C. only.

O. W. Richardson and M. Brotherton: Electron emission under the influence of chemical action at high gas pressures, and some photoelectric experiments with liquid alloys. The reaction investigated is that of $COCl_2$ at pressures not less than 0·001 mm. on drops of the liquid alloys of sodium and potassium. The electric currents are (1) proportional to the rate of drops (2) independent of the pressure of $COCl_2$ over a wide range. The distribution of velocity among the higher velocity electrons is Maxwellian: there is no sharp limit as in the photoelectric effect. The average energy is equivalent to a temperature of 2370° K. The chemical currents can be used to determine the contact potential between the drops and a second electrode. The results seem to agree with the hypothesis that the chemical action is propagated sideways at the edges of infected patches.

P. A. M. Dirac: The quantum theory of dispersion. One can consider a field of radiation to be a dynamical system whose canonically conjugate variables are the energies and phases of its Fourier components. One can then describe its interaction with an atom by a Hamiltonian function and obtain a satisfactory quantum theory of all radiative processes. The theory, when applied to the scattering of radiation by an atom, shows that two kinds of scattering processes can take place, namely, single processes for which a light-quantum simply changes its direction of motion, and double processes which are combinations of an absorption and emission. The sum of the two, when account is taken of their mutual interference, gives (excluding the case of resonance) just Kramers' and Heisenberg's dispersion formula. When the incident frequency coincides with that of an absorption line, practically the whole of the scattered radiation comes from transitions to the higher state and down, again governed by Einstein's laws.

Royal Microscopical Society[1] (Liverpool Conference), **Mar. 30 and 31.**—**Eric Ponder**: The diameter of the red cells of man before and after exercise. The red cells of man, or of any animal, may be measured without being brought into contact with any atmosphere other than one which is in equilibrium with the blood from which the cells are derived (technique of Dryerre, Millar, and Ponder). The preparations of cells, immersed in the plasma of the subject whose cells are to be measured, are made in a special chamber containing a gas mixture in equilibrium with the blood at rest or after exercise, as the case may be, the gaseous tensions of this blood being determined by preliminary analyses. These preparations are then photographed, and the diameter of the cells determined from the plates. There appears to be no difference in the mean diameter of the cells of the same individual before and after severe exercise.—**W. Ramsden**: Surface phenomena. Aqueous solutions of many organic solids of high molecular weight can be made to yield visible solid masses by treating them in such ways as will sweep up any particles present on their air-surfaces. The solutes used are solids which diminish the tension of a water-air surface, and the heaped-up surface-particles are termed 'massed adsorpta.' With the three proteins egg-albumin, fibrinogen, and edestin, the massed adsorpta undergo irrevisible coagulation and are insoluble in the mother liquids. With all other substances tested, including in these very many proteins, the massed adsorptum rapidly goes back into solution. The 'adsorptum-coated' surfaces are in some cases freely mobile (sodium oleate, bile-salts, quinine). In other cases (nearly all proteins, and saponin) sulphur grains or magnets floated on the surface are mobilised. All solutions capable of being blown into more than fugitive bubbles, or of forming stable emulsions with oils, contain solutes adsorbable at the interfaces concerned.—**J. Ross-Mackenzie**: The causes and correction of cloudiness in malt liquors. Brewing materials are extremely complex in composition, and the ever-changing character of nitrogenous substances produces cloudiness. The permanently soluble nitrogenous constituents are divided into two groups, 'assimilable nitrogen' and 'non-assimilable nitrogen.' The amount and type of assimilable nitrogen absorbed depends on the class of yeast used. A beer produced from British barley-malt and hops only would contain an excess of crude nitrogen; to overcome this excess the brewer is compelled to employ materials free from nitrogen as diluents. Composite yeasts are mainly used in breweries and 'wild yeasts,' in excess, are the main cause of cloudiness, abnormal flavours and odours, and general instability in beers.—**A. C. Thaysen and H. J. Bunker**: Some observations on the microscopical study of deteriorated fabric from early Egyptian tombs. Swabs were taken in the sepulchral chamber of Tut-ankh-amen's tomb immediately after opening and were tested for live bacteria and fungus spores. Though such were undoubtedly present when the tomb was sealed, no viable spores existed. Linen fabrics from this tomb and that of Queen Hetepheres, *circa* 3000 B.C., was examined to determine the cause of tendering. Probable fungus spores and fragments of mycelium were found in the Tut-ankh-amen material, but on swelling the fibres with sodium hydroxide, the appearance was typical of that produced when tendering is caused by hemical agencies. It seems that though microbioogical activity occurred on the fibres to a limited xtent and in localised areas, such action ceased comparatively soon after the sealing of the tomb and was superseded by a different type of deterioration, usually referred to as 'ageing.'

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[1] Continued from p. 766.

Dublin.

Royal Irish Academy, April 25.—**E. J. Sheehy**: The relative food values of brown (from entire wheat grain) and white (from endosperm of grain) wheaten flour, and their comparative potency for the prevention of xerophthalmia in guinea-pigs. Results of prolonged feeding experiments on guinea-pigs with estricted diets bear evidence of the superiority of brown over white flour as regards the content of vitamin A. Xerophthalmia appears earlier and more frequently in the group of animals fed on white flour and mangels than in the brown flour and mangel lot. The progress made by the group of animals fed on mangels, brown flour, and hydrogenated soya bean oil is similar to that made by those animals fed on mangels, white flour, and cod-liver oil.

Royal Dublin Society, April 26.—**W. R. G. Atkins**: The soluble silicate content of soils. The colorimetric method of Diénert and Wandenbulcke may be used o estimate the soluble silicate in an aqueous extract. Calculated on the weight of the air-dried soil the silicate, as SiO_2, was found to vary from 18 to 124 parts per million. No constant relation was observed between these figures and those for electrical conductivity or *p*H values, but the soils used had been tored.—**M. Grimes, H. S. Boyd-Barrett**, and **J. Reilly**: Methylene blue (reductase test) in milk grading.

Edinburgh.

Royal Society, May 9.—**D. Noël Paton**: Submergence and postural apnœa in the swan. An investigaion of the apnœa in the swan in feeding, showing hat it is postural and that both labyrinthine and neck reflexes are involved.—**H. Graham Cannon**: On the feeding mechanism of *Nebalia bipes*: Nebalia is a mud-living form feeding on food filtered from an antero-posterior food stream produced by the oscilatory movements of its trunk limbs. The latter are armed along their inner edges with four rows of setæ. The first and third rows are hooked and those of successive limbs interlock, forming a continuous filter wall. The fourth row are stiff setæ which comb the filtered food off the filter walls, and the second are brush setæ which sweep the food so gathered forwards o the mouth. The mouth parts both functionally and structurally resemble those of a mysid, and Nebalia probably arose from such a primitive form hat took to mud-living habits, the foliaceous limbs having developed in correlation with this new habitat.—**A. H. R. Goldie**: The structure and movement of the atmosphere as affected by diurnal variations. The main processes are (*a*) gravitational mass convection, ransferring heat upwards in accordance with Sandstrom's principle, which would in the long run lead to extreme stability in the vertical direction and great requency of inversions were it not for the operation of *b*), the waves and vortices due to discontinuous motions, however local, which operate to transfer heat downwards or horizontally at the cost of some of the energy of the general horizontal circulation and tend o obliterate the discontinuities. The final result is a stratification of the atmosphere with a fair degree of resilience' and in particular a semidiurnal variation; urbulence, initiated in the forenoon by such solar radiation as reaches ground level and initiated in the evening mainly by outgoing radiation from cloud masses or from air masses raised convectionally in the morning, leads at these times to a certain amount of mixing of layers with consequent retardation; on the other hand, in the late afternoon and the latter part of the night the laminarity of flow is improved.—**A. W. Greenwood** and **F. A. E. Crew**: On the quantitative relation of comb size and gonadic activity in the fowl. The law of 'all-nothing' formulated by Pezard does not hold in the case of comb volume. The degree of development of head furnishings is dependent not on the amount but on the degree of spermatogenic activity of the gonadic tissue.

Rome.

Royal National Academy of the Lincei, Mar. 6.—**L. Tonelli**: An approximation polynomial and the area of a surface.—**C. Somigliana**: Determination of geodic constants by means of measurements of gravity alone.—**O. M. Corbino**: Realisation of high positive and negative self-inductions by means of a three-electrode lamp and induction circuits.—**A. Lo Surdo**: The saturation current of thermionic valves. Experiments with various thermionic valves show that, in the phase of saturation, the current intensity is not constant but varies very nearly in proportion to the potential difference between the plate and the filament. Moreover, for any temperature of the filament of any one valve, the increases of the saturation current corresponding with definite increments of the anode voltage are, within wide limits, approximately constant fractions of the respective currents.—**J. M. Burgers**: Some investigations of Helmholtz and of Wien relating to the form of the waves at the surface of separation between two liquids.—**L. Fernandes** and **F. Palazzo**: Investigations on sulpho-salts (ii). Sulphoxypolymolybdates of ammonium and of guanidine. Treatment of the solution of a normal sulphomolybdate with even a relatively weak acid, such as acetic or formic acid, results in decomposition of the salt with evolution of hydrogen sulphide and precipitation of molybdenum sulphide. On the other hand, the sulphoxy-salts, although they are decomposed by strong mineral acids, undergo polymerisation similar to that experienced by the oxygenated salts under the action of weak acids in low concentration. A number of ammonium and guanidine sulphoxypolymolybdates have been prepared in this way.—**Remo de Fazi**: Alcoholic fermentation of glucose solutions exposed to the action of ultra-violet rays. When a glucose solution is exposed to the rays emitted by a quartz mercury vapour lamp, its optical rotation remains unchanged, but its subsequent fermentation by yeast is accelerated, often considerably, and the final liquid is appreciably more free from bacterial contamination than the untreated solution similarly fermented.—**G. Cotronei**: New observations on the influence of the nervous system in relation to nutrition with thyroid in the morphogenesis of the *Anura amphibia*.—**P. Pasquini**: Investigations on the experimental embryology of the echinoderms (i). Atypical segmentation and successive development of the egg of *Arbacia punctulata* (Grey) centrifuged after fertilisation. The resistance of the egg of Arbacia to centrifugal force is immediately modified by fertilisation, the plasma becoming more sensitive in some respects.—**U. D'Ancona**: Investigations on the increase in size of the eye of the eel in relation to sexual maturity, and considerations on its biological significance.—**L. Volterra D'Ancona**: Further as to the variability of the pelagic Daphnia of Lake Nemi.

Official Publications Received.

British.

Hull Museum Publications. No. 145: Record of Additions, No. 70. Edited by T. Sheppard. Pp. 47. No. 146: Hull's Art Treasures. By T. Sheppard. Pp. 56+15 plates. No. 147: Catalogue to the Hull Printing Trades' Exhibition, held at the Museum of Commerce and Transport, High Street, Hull, from March 17th to April 9th, 1927. Pp. 40+xxxvi. (Hull.)

Canada. Department of Mines: Mines Branch. Helium in Canada. By R. T. Elworthy. (No. 679.) Pp. iv+64+2 plates. (Ottawa: F. A. Acland.) 20 cents.

Aeronautical Research Committee: Reports and Memoranda. No. 1055 (Ae. 238): Tests on Handley Page Aerofoil A.1. and R.A.F. 31. Communicated by Messrs. Handley Page, Ltd. (A.2.a. Aerofoils General, 159, 160, 161.—T. 2213-14-15.) Pp. 32+11 plates. 1s. 3d. net. No. 1066 (Ae. 240): D. M. Smith's Method for the Determination of the Transverse Frequencies of Vibration of Uniform Beams. By T. W. K. Clarke and V. M. Falkner. (D.1. Special Technical Questions, 180.—T. 2296.) Pp. 9+2 plates. 9d. net. No. 1067 (Ae. 249): On the Contraction of the Slipstream of an Airscrew. By H. Glauert. (A.2.d. Airscrews, 90.—T. 2337.) Pp. 11. 6d. net. (London: H.M. Stationery Office.)

University Grants Committee. Returns from Universities and University Colleges in Receipt of Treasury Grant 1925–1926. Pp. 24. (London: H.M. Stationery Office.) 1s. net.

Pharmaceutical Society of Great Britain: Pharmacological Laboratories. First Annual Report, 1926. Pp. 7. (London.)

Journal of the Royal Statistical Society. Vol. 90, Part 2. Pp. x+225-432. (London.) 7s. 6d.

The University of Leeds: Department of Coal Gas and Fuel Industries (with Metallurgy). Report of the Livesey Professor for the Sessions 1924–25 and 1925–26. Pp. 14. (Leeds.)

Foreign.

Proceedings of the Imperial Academy. Vol. 3, No. 2, February. Pp. iii-iv+45-114. (Uyeno Park, Tokyo.)

University of California Publications in American Archaeology and Ethnology. Vol. 23, No. 4: Arrow Release Distributions. By A. L. Kroeber. Pp. 283-296. (Berkeley, Calif.: University of California Press; London: Cambridge University Press.) 25 cents.

Columbia University. Bulletin of Information, Twenty-seventh Series, No. 19: Professional Courses in Optometry; Announcement 1927–1928. Pp. 30+3 plates. (New York City.)

United States Department of Agriculture. Department Bulletin No. 1472: Chemotropic Tests with the Screw-Worm Fly. By D. C. Parman, F. C. Bishopp, E. W. Laake, F. C. Cook and R. C. Roark. Pp. 32. (Washington, D.C.: Government Printing Office.)

Department of the Interior: U.S. Geological Survey. Water-Supply Paper 550: Surface Water Supply of the United States, 1922. Part 10: The Great Basin. Pp. v+192+2 plates. 10 cents. Bulletin 790-B: The 'Palouse Soil' Problem, with an Account of Elephant Remains in Wind-Borne Soil on the Columbia Plateau of Washington. By Kirk Bryan. (Contributions to the Geography of the United States, 1926.) Pp. ii+21-45+plates 4-7. (Washington, D.C.: Government Printing Office.)

Proceedings of the United States National Museum. Vol. 71, Art. 1: Description of a new Species of Fresh-water Copepod of the Genus Moraria from Canada. By Arthur Willey. (No. 2672.) Pp. 12. Vol. 70, Art. 4: Miscellaneous Descriptions of new Parasitic Hymenoptera, with some Synonymical Notes. By A. B. Gahan. (No. 2676.) Pp. 39+1 plate. Vol. 71, Art. 6: A new Genus and Two new Species of South American Fresh-water Mussels. By William B. Marshall. (No. 2678.) Pp. 4+2 plates. (Washington, D.C.: Government Printing Office.)

Catalogues.

The West Indies: being a Catalogue of Books, Maps and Engravings relating to British and Foreign Possessions in the West India Islands. (No. 495.) Pp. 42. (London: Francis Edwards.)

Catalogue of Secondary and Higher Text-Books. Pp. iv+206. (London: G. Bell and Sons, Ltd.)

Errata List No. 1. Pp. 3. Circular 251A: Laboratory Coats, Aprons and Short Jackets. Pp. 2. Circular 264A: Standard Volumetric Glassware. Pp. 2. Circular 255: The "Alltest" Multi-Range Portable Moving Coil Instrument. Pp. 2. Circular 266: New Electrical Apparatus for the Determination of Molecular Weights by Rast's Camphor Method. Pp. 1. Circular 262A: Monax Laboratory Glassware. Pp. 4. "Schola" Beakers and Flasks. Pp. 3. (London: A. Gallenkamp and Co., Ltd.)

Illustrated Price List of Apparatus for Radiology (Abridged). 1927 edition. Pp. 64. (London: Newton and Wright, Ltd.)

Rare and Valuable Books. (No. 17.) Pp. 126. (Newcastle-on-Tyne: William H. Robinson.)

Diary of Societies.

SATURDAY, May 28.

Institution of Municipal and County Engineers (South Wales District Meeting) (at Town Hall, Newport), at 9.30 a.m.

North of England Institute of Mining and Mechanical Engineers (Associates and Students Section) (at Neville Hall, Newcastle-upon-Tyne), at 3.—W. S. Armstrong: Variable Speed Gears and their Application for Colliery Purposes.—Paper open for further discussion: The Ventilation of a Pyrites Mine, with Special Reference to Fire-Fighting, Safety and Rescue-Work, R. White.

MONDAY, May 30.

Victoria Institute (at Central Buildings, Westminster), at 4.30.—Rev Prof. R. D. Wilson: The Radical Criticism of the Psalter.

Surveyors' Institution (Annual General Meeting), at 5.

Royal Institute of British Architects, at 8.—T. Hastings: Devon shire House Buildings.

Royal Geographical Society (at Æolian Hall), at 8.30.—W. F. P Burton: Central Katanga.

TUESDAY, May 31.

Royal Society of Arts (Dominion and Colonial Meeting), at 4.30.- Dr. T. Baldasano: Spanish Morocco.

Royal Photographic Society of Great Britain, at 7.—H. A Bierman: (a) The Development of Chloro-Bromide Papers; (b) Th Exposure of Colour-Screen Plates.

WEDNESDAY, June 1.

Royal Society of Medicine (Surgery Section), at 5.—Sir Jame Berry, G. Turner, and others: Discussion on The Treatment of Cle Palate by Operation.

Royal Microscopical Society, 7.30 to 10.—Annual Pond Life an General Microscopical Exhibition.

Entomological Society of London, at 8.—Dr. H. Scott: Narrative an Entomological Expedition in Central Abyssinia.

THURSDAY, June 2.

Genetical Society (Annual General Meeting) (at Linnean Society), at —Dr. R. A. Fisher: Light and Dark Lines in Pied Mice.—C. Diver The Problem of Natural Selection in Relation to Helix (Cepaea).- Prof. R. R. Gates and Miss M. L. Sheffield: On Meiotic Arrangement in Oenothera and their Bearing on Segregation.—W. C. F. Newton Sex in *Silene Otites* Agg.

Royal Society, at 4.30.—Prof. S. Chapman and A. E. Ludlam: Theoretical Discussion of certain Elastic Constants of Calcite an Crystalline Sodium Nitrate.—R. W. Fenning and H. T. Tizard: Th Dissociation of Carbon Dioxide at High Temperatures.—L. E Callendar: The Influence of Boundary Films on Corrosive Action.- *To be read in title only*:—N. R. Sen: On Fresnel's Convectio Coefficient in General Relativity.—C. F. Elam: Tensile Tests on Allo Crystals.—A. J. Bradley and J. Thewlis: The Crystal Structure of Manganese.

Chemical Society, at 8.—U. R. Evans: The Passivity of Metal Part I. The Isolation of the Protective Film.—Prof. T. M. Lowr and R. R. Goldstein: Studies of Valency. Part VIII. The Molecul Structure of Vernon's Dimethyltelluronium Salts.—E. Roberts an E. E. Turner: The Factors Controlling the Formation of Som Derivatives of Quinoline, and a New Aspect on the Problem of Su stitution in the Quinoline Series.

Institution of Municipal and County Engineers (Scottish Meetin (at Dunfermline).

FRIDAY, June 3.

Physical Society of London (at Imperial College of Science), at 5. Dr. E. H. Rayner: The Forthcoming Eclipse of the Sun (Lecture).

Royal Institution of Great Britain, at 9.—Dr. G. M. Trevelya Carlyle as an Historian.

Royal Society of Medicine (Social Evening), at 9.30.—Dr. G. W. Kaye: X-rays, and some of their Uses.

Institution of Municipal and County Engineers (Scottish Meetin (at Dunfermline).

SATURDAY, June 4.

Institution of Municipal and County Engineers (Scottish Meetin (at Dunfermline).

Institution of Municipal and County Engineers (South-Easte District Meeting) (at Maidstone).

PUBLIC LECTURES.

SUNDAY, May 29.

Guildhouse (Eccleston Square, S.W.), at 3.30.—Prof. J. Garstan Recent Discoveries in Palestine.

TUESDAY, May 31.

Chelsea Physic Garden (Swan Walk, Chelsea Embankment), at 5 B. Gerritsen: The Growing, Marketing, and Exporting of Fruit a Vegetables in the Netherlands (Chadwick Lecture).

THURSDAY, June 2.

Institute of Pathology and Research, St. Mary's Hospital, at 5 Prof. C. A. Lovatt Evans: The Alkalinity of the Blood.

CONVENTIONS.

June 6 to 9.

Convention of Canadian Chemists (at Quebec).

June 6 to 11.

Photographic Convention of the United Kingdom (at Warwick).

Monday, June 6.—Afternoon.—Welcome by the Mayor of Warw Installation of President. Presidential Address. Annual Gene Meeting.

Tuesday, June 7.—Evening.—H. Baker: Lecture.

Wednesday, June 8.

Thursday, June 9.—Evening.—A. S. Newman: Lecture.

Friday, June 10.—Evening.—A. Keighley: Lecture.

Saturday, June 11.

SATURDAY, JUNE 4, 1927.

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No. 3005, Vol. 119]

British Chemical Abstracts.[1]

THE appearance of the first index volume, covering the whole of the abstracts in pure and applied chemistry issued during 1926 under the direction of the Bureau of Chemical Abstracts, is a notable achievement. Marking, as it does, the completion of the first period in what promises to be a valuable co-operative and unifying enterprise, it represents a definite British contribution to the armoury of chemical knowledge and research. So far as the fields of physical, inorganic and organic chemistry, biochemistry, and chemical technology are concerned, few investigations of real importance, few new facts or measurements, few patents of chemical processes, can have failed to be reported in the abstracts on which this index is based. Since the rate of advance in any branch of knowledge so largely depends on an adequate acquaintance with the experimental results and theoretical views which form the starting-point of any new research, the efficiency of the abstracting and indexing service is a matter which closely concerns every investigator, teacher, and student.

Since 1871 the Chemical Society has undertaken, on a systematic and extensive scale, the preparation and publication of abstracts of papers in pure physical, inorganic, organic, analytical, mineralogical, and biological chemistry; besides the annual indexes, collective indexes have been issued covering the periods 1841–72, 1873–82, 1883–92, 1893–1902, 1903–12, and 1913–22. The Society of Chemical Industry has similarly surveyed applied chemistry since 1882, and has published collective indexes for the periods 1882–1895 and 1896–1905.

Naturally, a considerable amount of material appeared in both publications, and from time to time tentative efforts were made in the direction of collaboration. Real co-ordination, however, was initiated only in 1924, when the Bureau of Chemical Abstracts, composed of four representatives from each of the two societies, was constituted with the object of securing, so far as might be possible, unification of the two sets of abstracts. Ever since the Bureau was established, Prof. J. C. Philip has acted as independent chairman, and the new organisation has also had the advantage of the advice, in an honorary capacity, of Mr. A. J. Greenaway, formerly editor of the *Journal of the Chemical Society*. The regular staff of the Bureau consists of an editor, Mr. T. F. Burton, supported by eight specialist assistant editors, each in charge of an appropriate branch, and a large staff of abstractors, as well as an expert indexer. The publication as a whole, composed of two sections dealing with abstracts in pure and applied chemistry, is now known as "British Chemical Abstracts"—A and B, respectively.

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[1] British Chemical Abstracts issued by the Bureau of Chemical Abstracts. Index, 1926. Pp. 430. (London: Society of Chemical Industry.)

At the outset, the possibility of co-operation with the American Chemical Society with the object of producing one chemical abstract publication in the English language was thoroughly explored, but progress in this direction proved to be impracticable. The Bureau then proceeded, with what patience and persuasiveness one can only surmise, to secure consent to a common format for the two sections of the abstracts, and a joint index. Thanks to the Chemical Society's action in giving up its well-known octavo format, agreement was reached in 1925 and the new scheme was initiated in January 1926. From that date onwards both A and B abstracts have been published—the former monthly, the latter fortnightly—in double column quarto, the overlap has been eliminated, and the A abstracts (pure chemistry) rearranged and paginated continuously, whilst the type and set up of the B abstracts (applied chemistry) have been brought into conformity with the A section. The first year of this new arrangement has now been completed by the publication of the index part, consisting of 430 pages. It has been necessary to adjust differences in the two systems of indexing previously employed, and to deal with some 50,000 index cards, so that the Bureau may be excused if the publication, which is to serve as a model, appears later than was hoped.

The index *qua* index requires little comment. It is based on the nomenclature and arrangement adopted by the Chemical Society; it includes a list of patents and a list of the journals abstracted; but not, unfortunately, a formula index, that expensive luxury.

In two respects, perhaps, the service offered to the chemist by "British Chemical Abstracts" is such as to merit his special attention. In the first place, it offers him abstracts which are admittedly second to none in accuracy; it is the policy of the Bureau that, so far as is practicable, the abstracts shall be prepared by abstractors and examined by editors who have specialised knowledge of the subject concerned. The degree of detail permitted in the abstracts depends to some extent on the accessibility of the original publication to British chemists, but every new substance is specifically mentioned. In the second place, promptness in the publication of abstracts is regarded as being of primary importance, and "British Chemical Abstracts," when compared with other similar publications, proves to have an excellent record in this matter.

According to the list at the end of the index, some 400 journals come directly or indirectly under the review of the Bureau's staff. It is of course financially impossible at present to spread the net so wide as does the corresponding American publication; moreover, it is doubtful whether much advantage would accrue from the inclusion of a large amount of ephemeral, borderline, and even non-chemical matter. A systematic survey of all possible sources of information is, however, made, and certainly there can be very little valuable information that escapes the attention of the Bureau and its staff. Much of the so-called borderline material is of course abstracted by other bodies—scientific and trade societies and research associations—the scope of which, although sufficient for their own purposes, is admittedly incomplete. It might conceivably be possible to secure some measure of effective co-ordination or co-operation between the Bureau and such organisations as would result in financial advantage as well as economy of effort on the part of the user. The Bureau would no doubt welcome constructive criticism, and give the most careful consideration to any suggestions calculated to enhance the value of its publications.

The Peoples of Sarawak.

Natural Man: a Record from Borneo. By Dr. Charles Hose. With a Preface by Prof. G. Elliot Smith. Pp. xvi + 284 + 60 plates. (London: Macmillan and Co., Ltd., 1926.) 30*s*. net.

THOSE who desire to gain some knowledge about the attractive inhabitants of Sarawak will find what they require in this interesting and informative book by Dr. Hose. All the information here given about the natives, and much besides, will be found in the "Pagan Tribes of Borneo," by Dr. C. Hose and Dr. W. McDougall. The serious student cannot afford to neglect the older work, but sufficient material will be found in the new book to satisfy most other readers. Owing to his long residence in the country, his intimate and sympathetic knowledge of most of the tribes, and his friendship with many individuals, Dr. Hose not only writes with authority, but also is able to handle his multitudinous facts with ease and to bring out the essential points of material d social culture, besides giving a good insight to the mental and moral characteristics of the ore important peoples. The value of the book enhanced by the very numerous and beautiful hotographs, which were mostly taken by the uthor and do really illustrate the text. A certain umber, including two of the four coloured plates, ppeared in the older work, but many are new and ll are appropriate. There is a useful map of ibal distributions.

Dr. Hose deals at the beginning with Borneo hen it was inhabited solely by hunters and colectors of jungle produce. Then cultivation (more articularly of rice), metal-working, the building f long-houses, and any other cultural lements were introduced; most of the boriginal population ssimilated these to a reater or lesser extent, and this congeries of tribes has been named the Klemantans by Dr. Hose. ertain groups, however, persisted in the ld way of life; these re the Punan and llied wanderers in he jungle. Later igrations of people with a similar culture, but more highly organised socially and possessing greater physical and mental virility, were those of the Kayan-Kenyah peoples, whose cultural affinities with tribes in northern Burma and in Assam have often been noted. These are the most advanced of the true Borneans, and it is with them that the book mostly deals; they appear to have entered Borneo from the south. The north was affected by the invasion of the Murut, who, Dr. Hose thinks, came from the Philippines or from Annam. They were not a water folk, and are supposed to have introduced terrace cultivation, the buffalo, and various distinctive weapons and customs; they do not use the blow-pipe. The last migration, which is estimated to have occurred less than 300 years ago, was that of the Iban, or 'Wanderers' (the so-called Sea-Dayaks), who under Malay leadership raided the north-west and penetrated up numerous rivers, a turbulent crowd glorying in head-hunting. There appears, however, to have been an earlier immigration of the same stock, but of gentle manners and more settled habit.

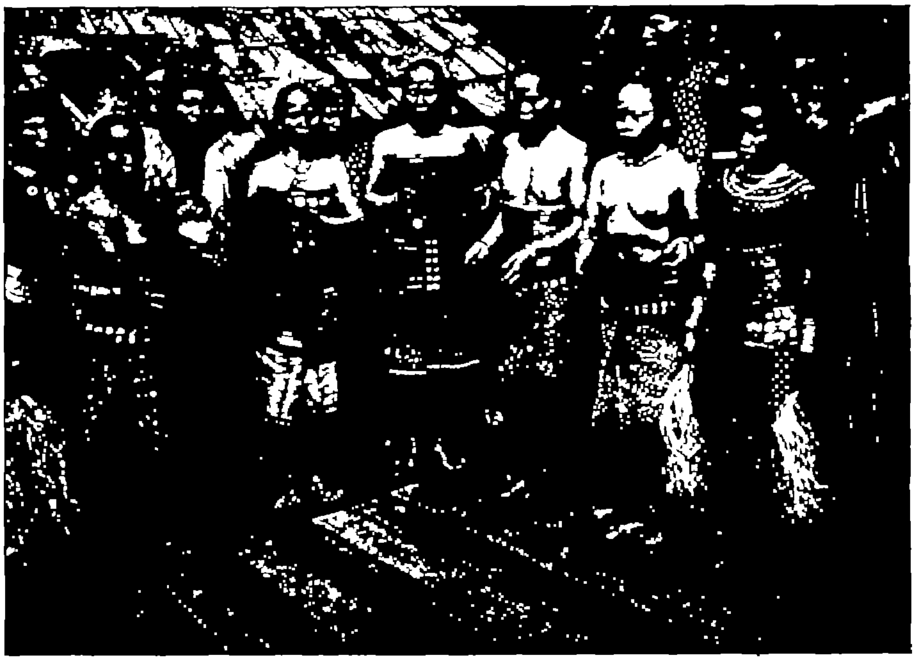

Fig. 1.—Iban women dancing with the heads of enemies at a festival. (From "Natural Man.")

The great resources of Borneo attracted the Chinese more than a thousand years ago, and at intervals they claimed a partial suzerainty. Before the Mohammedan Malays became dominant in Brunei it was a Bisayan kingdom under Buddhist sovereigns. Indo-Javanese influence made itself felt, more especially in the west, of which traces still persist. Pigafetta in 1521 was the first European to visit Borneo, and various abortive attempts to settle in the island were made by Europeans in the seventeenth century. The Dutch eventually established themselves in the south, and in 1839 the brilliant and adventurous James Brooke arrived on the north coast and shortly afterwards became Rajah of Sarawak. He instituted a policy of administration than which nothing could be better for the local conditions; this has been successfully followed by Rajah Sir Charles Brooke and the present Rajah, Sir Charles Vyner Brooke. The policy has always been to interfere as little as possible with native custom and belief, but necessarily life and property had to be made secure. As an example of the care for the people, it may be noted that many years before the rubber boom of 1910–11, Para rubber seeds had been imported and the natives were encouraged to plant rubber for their own profit. The Rajah caused notices to be published that the natives were at full liberty to appropriate forest lands for this purpose, which would remain their property so long as they took care of the trees and worked the rubber properly. He also ordered that no sales of rubber plantations should be effected without the approval of the Government, and thus prevented exploitation by outsiders.

The administration of subject races, more particularly those in Africa, is a topic which is now being widely discussed. The method adopted in Papua has proved most excellent for peoples of very backward culture, and that employed in Sarawak is as admirable for somewhat more advanced peoples.

A. C. Haddon.

The Chemistry of Plant Activities.

Photosynthesis. By H. A. Spoehr. (American Chemical Society Monograph Series, No. 29.) Pp. 393. (New York: The Chemical Catalog Co., Inc., 1926.) 6.50 dollars.

ALTHOUGH not actively engaged as a teacher, the author has done a considerable service to education in writing a book on photosynthesis as he understands it. The educational value of this book, however, lies not only in the actual information it gives on what may be called the more descriptive physiological aspects of the phenomenon, but also on the broadness of outlook displayed in the treatment of the whole subject. With commendable thoroughness the author has put a very liberal interpretation upon the word 'photosynthesis,' and has drawn into his purview a number of aspects which might perhaps scarcely have been expected to have received the careful consideration which he has given them. Thus the cosmic and economic aspects of the problem are dealt with at considerable length, and are amplified and illustrated by numerical data which contribute materially to a proper appreciation of their significance; likewise the purely chemical and physical aspects are dealt with in a very lucid and thorough manner. It is by adopting this very comprehensive attitude towards the subject that the author points the way to future progress, for the reader will realise that many gaps in our knowledge of chemistry and physics need to be filled before there can be much hope of a better understanding of the process of assimilation of carbon by green plants.

The book is divided into seven chapters which are, in effect, complete monographs of the various aspects of the question with which they de being supplied with continual references to origin literature. From the point of view of the teach or the advanced student, this is altogether excellen since the book may be confidently relied upon present a complete account of our present knov ledge of the subject concerned. To the le experienced student this wealth of informatic may perhaps be a little embarrassing, more partic larly as the author has an occasional tendenc to break away from a subject and to return t it again later, which makes it necessary for th student to connect the various pieces togeth before he can get the continuous story.

The opening chapter, entitled "The Origin Organic Matter and the Cosmical Function Green Plants," is one of particular interest. The is probably no other book in which such a complet account of this aspect of the subject is to be found the author has here collected together a mass data with regard to solar radiation and the di posal by the leaf of the solar energy incident upo it, and illustrates it graphically in a very convincin manner. Here also will be found a comprehensiv discussion of the solubility of carbon dioxide i fresh and sea water and its significance to aquati plants, as well as a discussion of the economi aspects of the utilisation of the solar energy store by the products of photosynthesis. Many of th data furnished in this very interesting chapter ar culled from American sources which, thoug possibly easily accessible, are not familiar to th average reader.

The second chapter deals with "The Nature o Photosynthesis as Determined by Observation of Gas Interchange and the Formation of Organi Matter." This is by far the longest chapter in th book, and is the one which will appeal more par ticularly to the plant physiologist. Describing firs the path of the gaseous interchange at the surfac of the leaf and the work of Brown and Escombe the author passes on to a consideration of th carbon dioxide content of the soil atmospher and of natural waters. After carefully distinguish ing between the terms 'photosynthetic' an 'respiratory quotient,' he introduces the principl of limiting factors. In discussing the effect o light he wisely administers a much-needed warning to those who may still be in need of it— and, sad to say, there are still a good many—ir the following words: ". . . there is no sense ir considering the photosynthetic activity in different coloured light without at the same time determining the energy relations of the light employed."

Attention is also directed to the fact that "the method of measuring the rate of photosynthesis by the appearance of starch in the leaf cannot be considered as being very accurate," since the formation of starch is itself not dependent upon the presence of light. He also administers the *coup de grâce* to one other much-cherished idea by the statement that "there is apparently no relation between photosynthetic efficiency and the absorption bands of chlorophyll." After dealing successively with each of the various limiting factors in detail, the chapter is brought to a close with an account of the more recent work of Plaetzer, Harder, and Warburg on the 'compensation point,' that is to say, the light intensity at which the respiratory and photosynthetic activities compensate each other.

In Chapter iii., entitled "The Products of Photosynthesis," the author gives a fairly exhaustive description of the occurrence and character of such carbohydrates as are found in the leaf, and may therefore be regarded as being, at any rate potentially, primary products of photosynthesis, and on these grounds excludes from this description such substances as trehalose, raffinose, melicitose, etc. Here also will be found a good summary of the vexed question of what is the first product of photosynthesis. The succeeding chapter gives a very clear account of the methods of measuring photosynthetic activity.

In Chapter v. the author sets forth in characteristically thorough manner the various hypotheses regarding the steps in photosynthesis. He says of Baeyer's theory that "it is a good suggestion of a possible mechanism of photosynthesis," but of recent work purporting to support the formaldehyde theory he says: "Condensing formaldehyde with strong alkalies or through the action of ultra-violet light and obtaining a great mixture of substances of which only a small per cent is in many cases hexose sugar, will, even to the most optimistic chemist, appear as a rather far cry to the method by means of which the plant forms glucose."

Chapter vi., on the energy relations in photosynthesis, contains a valuable summary of all the more recent work on this difficult subject, while Chapter vii. gives a fairly detailed but well-summarised account of the methods of isolating the various leaf pigments, including the separation of chlorophyll-*a* and -*b*; there is also a section devoted to the chloroplast.

There is a considerable number of misprints, more particularly of plant names, one of the most peculiar distortions being that of Heleodea for Elodea on p. 85. The book provides, however, most interesting and inspiring reading; it is impartially critical, and frequently indicates the direction in which further work is desirable. The author has produced a work for which teachers both of plant physiology and of chemistry should be very grateful.

The Future of Magnetism.

Magnetism and Atomic Structure. By Dr. Edmund C. Stoner. Pp. xiii + 371. (London: Methuen and Co., Ltd., 1926.) 18*s*. net.

IT is probably recognised by every one that the main interest in physics of to-day lies in the study of the atom. Much of the information with regard to the atom has been obtained by studying spectra; chemistry, magnetism, X-ray scattering, etc., play only a subsidiary part. We must admit, however, that our spectroscopic material is now more or less exhausted, and that we must look for fresh sources of information.

Much may be said in support of the opinion that magnetism will open a new way by which to approach the study of the structure of the atom. The atom is essentially an electromagnetic system which consists of a positively charged nucleus with negative electrons revolving round it. If the atomic number of the atom is given with its nuclear charge, and if the electrons arrange themselves round the nucleus in a definite way, then this arrangement of the electrons practically fixes all physical and chemical properties of the given element.

The magnetic field is probably the only practical weapon by means of which we may hope to change the motion and arrangement of the electrons in the atom, and thus influence all the physical and chemical properties of the atom. In only a very few cases at the present time do we find that the influence of the magnetic field on the properties of the atom is noticed. This is because the influence of the available fields is too weak to produce a marked change in the properties of the atom, and our present methods of magnetic research are not sufficiently refined to study them. The most easily observed magnetic phenomenon is the Zeeman effect, and this has a tremendous influence on the present theory of the structure of the atom.

It is possible that the difficulty of experimenting in magnetism, and the small amount of trustworthy experimental work done, account for the fact that magnetism has been somewhat neglected. During the last few years, however, a considerable amount of research has taken place, and new methods of approaching the subject have been developed, and we now have to recognise a marked advance in magnetism.

It is on this account that we have to welcome Dr. Stoner's book, especially as it attempts to give an account of our present knowledge of theoretical and experimental magnetism from the point of view of its relation to the structure of the atom.

The task of writing such a book, the counterpart of which has not before been published in any language, is indeed difficult; and in his preface Dr. Stoner himself admits the difficulty. The material which an author of a book on magnetism has at his disposal is very large, but the great amount of contradiction in experimental as well as in theoretical work makes the problem of selection very considerable.

In his preface Dr. Stoner states, "Prominence is given to the work which is thought to be of most important and lasting value," and the difficulty of selection may be illustrated by the following example. In Chapter xii. (p. 273, para. 4), Glaser's experiments are described at length, and in Chapter xv. they are well discussed. A few weeks before Dr. Stoner's book appeared, however, Glaser's experiments were repeated by Lehrer by a more refined method (*Z. für P.*, vol. 37), and it was shown that the increase of atomic diamagnetic susceptibility at low pressures in diamagnetic gases, as observed by Glaser, is almost certainly due to experimental error. This example is given, not to criticise Dr. Stoner's work, but simply to illustrate the difficulty of his undertaking.

On the whole, we must agree with Dr. Stoner's choice and with the manner in which he has put together the material at his disposal. The experimental and theoretical parts of the book are well divided; it is free from heavy mathematics; the subject is well brought up-to-date, and the references which follow each chapter are very valuable.

Dr. Stoner also gives a brief account of electrodynamics, the quantum theory, and other work which has been done on the structure of the atom, so as to enable the unprepared reader to follow the main subject of the book. We scarcely consider that such a brief account is sufficient to impart the preliminary knowledge necessary to follow the subject of the book—it can be regarded only as a means of recalling certain facts with regard to electrodynamics and the quantum theory to the mind of the reader who is already acquainted with them. It is doubtful whether it is reall advisable to include this account in the book.

In general, the book is of more use to th experimentalist than to the theoretical researc student. A close study of it reveals one or tw slips and misunderstandings, but none of a ver serious nature. Attention may be directed t one of these, and that is on p. 196, where Dr Stoner makes some calculations on the gyro magnetic effect. In this connexion the equation (9·2) are wrong, as the author puts the sign o equality between two expressions which cannot b equal. On the following page he himself suggest that this may be 'wholly wrong,' and so it is.

It is probable that as magnetism attracts mor and more attention, and as its importance in th study of the atom increases, we shall soon hav more books published on this subject. Dr. Stoner's book is, however, the first on this subject, and we welcome it as a very good commencement and as an important contribution to our present literature on magnetism.

P. Kapitza.

The Educational Ladder.

Social Progress and Educational Waste: being a Study of the 'Free-Place' and Scholarship System. By Kenneth Lindsay. Pp. vii + 215. (Studies in Economics and Political Science, No. 88.) (London: George Routledge and Sons, Ltd., 1926.) 7*s.* 6*d.* net.

Mr. Kenneth Lindsay, who was Labour candidate at a recent parliamentary election in Oxford, has written a very instructive study of the adequacy of the provision made for scholars to pass upwards from the elementary school to higher places of education, and the use made of it. He quotes with justifiable scepticism Lord Birkenhead's recent dictum that "the number of scholarships from the elementary to the secondary school is not limited, awards being made to all children who show capacity to profit"; and examines the actual facts carefully in four or five selected districts—London, Oxfordshire, Warrington, Wallasey, with a shorter account of Bradford.

The book is an interesting illustration of the fact that, however small and technical the point of departure may be, if the argument is pursued faithfully, a survey of all the connected fields is gained. This is especially true of sociology, and Mr. Kenneth Lindsay, by his thoroughness and acuteness, manages to give us a fairly complete sociological picture of London and some of the other places simply by following the record of the scholars proceeding from the elementary to the secondary schools in the area.

The main conclusions may be very briefly summarised. The ladder of which Lord Birkenhead spoke affects at most 20 per cent. of the elementary school population; 80 per cent. go no further in their scholastic education. It also appears quite clearly that the minority who do pass on are mainly from the lower middle class of clerks and small traders, and that their children by their continued education are enabled to remain or rise a little higher in the same class. Individual cases are mentioned of the sons of manual workers who become professors or civil servants, but it is abundantly proved that the mass of the workers are untouched by the secondary system. The root of the difficulty is poverty. Even if more secondary and central schools were provided, the need of the parents for their children's earnings would prevent any large number taking advantage of them.

To Mr. Kenneth Lindsay this fact points to a much more generous subvention from the State towards the maintenance of scholars: he indicates his own belief in an all-round allowance to parents. From the educational point of view the book will incline most of us to the solution just advocated in the Report of the Consultative Committee on Adolescent Education, namely, the gradual raising of the universal school age to fifteen years as economic conditions permit, that is, concentrating more on the improvement of the education of all than on a large immediate increase either in secondary schools or in scholarships.

F. S. M.

Our Bookshelf.

The Work of the Royal Engineers in the European War, 1914–1918. Compiled by Col. G. H. Addison. Published by the Secretary, Institution of Royal Engineers, Chatham. Miscellaneous. Pp. iii + 372 + 100 plates. (Chatham: W. and J. Mackay and Co., Ltd., 1927.) 20*s*.

THIS volume, the last of the series prepared by Col. Addison to illustrate the manifold activities of the corps of Royal Engineers during the recent European War, covers a wide range of activities. It shows in what manner the corps rose from 1569 officers and 23,521 other ranks (including Territorials) in August 1914 to 11,830 officers and 225,540 other ranks in August 1918. The mere list of units included in 1918 shows what the developments in warfare had brought under the control of the corps: water boring, sound ranging, tunnelling, gas and anti-gas methods, meteorology, land drainage, forestry, laundry, cinema and camouflage were amongst the many which the engineer-in-chief had to organise and supply with stores.

The subject of most general interest in this volume is the account of the camouflage service. Once again we see the shattered tree near Burnt Farm, and we learn that Colonel Solomon drew its bark from the King's Park at Windsor. It is not without some amusement that we note that for purposes of R.E. the artists in the Camouflage section were rated as painters and the sculptors as plasterers. From the chapter on the organisation of engineer intelligence and information emerges the somewhat startling fact that none of the maps supplied to the Army by the French staff recorded the existence of the unfinished Canal du Nord.

The chapters on concrete defences, on forward communications (duckboard tracks, decauville, mule tracks, plank roads, etc.) and on machinery, workshops (with the wonderful list of articles manufactured by the R.E. during the War), and electricity have their own special interest and might serve as a very useful text-book for engineers engaged in pioneer work in the outposts of civilisation. The concluding chapters on searchlights, inundations (our own and the enemy's), and training schools help further to illustrate the magnitude of the whole task of organising the engineering services required in the War and the success with which the task was accomplished.

Practical Organic and Bio-Chemistry. By Prof. R. H. A. Plimmer. New edition. Pp. x + 568. (London: Longmans, Green and Co., Ltd., 1926.) 21*s*. net.

THE need for a new (the third) edition of this book is in itself an indication of the appreciation of the public to which it is addressed. The author in revising his work, in addition to making numerous changes of detail, has again to some extent modified its scope. The book has been made more theoretical and less practical and at the same time more elementary.

We greatly regret this decision on the part of the author. Instead of developing into a valuable aid to laboratory practice in general biochemistry, the book is gradually becoming unequal in its treatment of various branches of the subject and overweighted with theoretical matter, much of which is too condensed (*e.g.* the anthoxanthins, the terpenes, and the alkaloids) to be of value for the class of students for which the main bulk of the book is intended.

Considered as a text-book for medical students, however, the book preserves the qualities which it has always possessed, and the sections on proteins, colloids, and digestion may all be cited as characteristic examples of the mode of treatment.

If, however, its virtues have been retained, so have some of its vices. The author still omits all reference to hydrogen ion concentration, its determination and its influence on biochemical phenomena. This constitutes a very serious, and in our opinion inexcusable, defect from which the book suffers throughout. The student, medical or other, who relies upon this work will find himself in this respect deprived not only of a general point of view of the greatest utility, but also of much valuable information, and will be greatly hampered if he should attempt to enlarge his ideas by reading current biochemical literature.

A large amount of new information has been incorporated into the text; thus glutathione, thyroxine *à la* Harington, and the irradiation of cholesterol are all included. On the other hand, oxidation-reduction potentials and the bacterial production of acetone and butyl alcohol from starch seem not to be mentioned. A. H.

Home Fires without Smoke: a Handbook on the Prevention of Domestic Smoke. Edited by Cyril Elliott and Marion FitzGerald. Pp. xvi + 59. (London: Ernest Benn, Ltd., 1926.) 3*s.* 6*d.* net.

THIS small book is of the popular type setting forth in simple language the existing methods available for preventing domestic smoke. There is a useful foreword by Sir Napier Shaw, and four chapters by different authors. Solid fuels are dealt with by Dr. M. Fishenden, gas by Mr. F. W. Goodenough, electricity by Major F. H. Masters, and the general housewife's problem by Miss Bushell and Miss Gordon. The book should help those desirous of knowing what they can do to eliminate domestic smoke.

Dr. Fishenden is a strong advocate of coke as a fuel for continuous use. Mr. Goodenough gives a very clear review of the possibilities of gas. He directs attention to a point not sufficiently realised when comparing the cost of gas for domestic use with that of solid fuel, that is, the saving of the time of the housewife. The case for electric heating and cooking is naturally supported strongly by Major Masters; he makes a good deal of the efficiency with which electricity is converted into heat and utilised, but no stress is laid on the necessity first to convert coal into electricity, with a heavy loss in the process. In his foreword, Sir Napier Shaw emphasises the scale of the smoke problem, a point often forgotten. Referring to the possibility of substituting gas and soft coke for the large amount of coal burned each year in domestic fires, he directs attention to the problem of disposing of the gas if sufficient coal were treated.

It is stated by Mr. Goodenough (p. 18) that gas "is probably available to something like 95 % of the population of these islands," and, on the same page, that "some forty million tons of coal are still burned in British dwelling-houses every year." These two statements taken together show that the disposal of the gas would be a real difficulty.

The book is not provided with an index, although a fairly complete list of contents is given.

J. S. OWENS.

Les physiciens hollandais et la méthode expérimentale en France au XVIII^{e} siècle. Par Prof. Pierre Brunet. Pp. ii + 153. (Paris: Albert Blanchard, 1926.) 14 francs.

THE legacy of Newton and his contemporaries of the seventeenth century has often been described. This was the century, too, that saw science organised through its societies on rational lines that at the same time made possible internationa relationship and collaboration on a scale hitherto impossible. The excellent volume before us deals with the handling of this legacy by the continenta physicists of the eighteenth century. It is perhaps insufficiently realised that international relationship has affected the progress of science almost as often as it has the progress of peoples; and the historian of science who is concerned with the development of the broader aspects of his subject is confronted with continual illustrations of this. The French Descartes lived his scientific life in Holland; Huyghens was a Dutch philosopher who worked in France and visited England; 'S Gravesande, of Leyden, was a member of the delegation of 1715 sent to England to congratulate George I. on his accession. Desaguliers was a Dutch philosopher who was educated in England. Here are but a few of the ingredients of international relationships in science. The eighteenth century was notable for the rise of the Dutch experimental school of physicists, and the story of the development of the experimental method in Holland, and of its influence on the mathematical methods of the French school, is dealt with by Prof. Brunet with a sympathy, a penetration, and an understanding that has resulted in a volume of unique value to all students of the history of science.

I. B. H.

Mongrel Virginians: The Win Tribe. By A. H. Estabrook and I. E. McDougle. Pp. 205 + 2 plates. (Baltimore, Md.: Williams and Wilkins Co.; London: Baillière, Tindall and Cox, 1926.) 13*s.* 6*d.* net.

THIS study of a group of Indian-white-negro crosses is a sociological and eugenic study of a group which has lived in the same locality in Virginia for more than a hundred years. It originated from a white-Indian union, with later introductions of 'mean-white' and negro strains. The group consists of about five hundred individuals in an area approximately eight miles long by four miles broad. They are mostly living on the land. The original white family, judging from its social and economic position, was probably above the average. The descendants are almost without exception below the low white in average ability.

One hundred and forty-five pages of the book are taken up with a history of the individuals so far as it has been possible to recover it, and this is followed by certain deductions from the data as to fecundity, consanguinity, legitimacy, and the like. As a sociological record this material has value; but as a scientific study it leaves much to be desired. The fact that a large number of the females have been prostitutes, and that white men from outside have resorted, and continue to resort, to the area, introduces an element of uncertainty into the data. Further, it is to be regretted that advantage has not been taken of such a promising opportunity to examine on anthropological and genetic lines such exceptional material for the study of a number of problems relating to heredity, inter-breeding, and racial crossing.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Transmutation of Elements.

PROF. A. SMITS, in a letter in NATURE of Jan. 2, 1926, announced the possibility of transmuting lead into thallium and mercury. In the December number of *Zeits. f. Elektrochem.* these experiments are described in more detail by Smits and Karssen. They used a quartz tube, furnished with two steel electrodes with carbon points, which dip down into the liquid lead. The amount of lead used is about 900 grams, which is kept liquid in a side tube all the time. When an experiment is performed, the tube is tipped and the lead is brought over into the main tube. The arc which is burning between two inner surfaces of lead is either continuous or intermittent, the main consideration being to obtain as high a current density as possible. The first method gave strong spectroscopic evidence of mercury and thallium after 10 hours' burning at ±35 amp. The second is the so-called sparking method, in which a current of 60-100 amp. can pass through the tube at the make of the arc, that is, when the tube is short-circuited through the liquid lead. Here all the mercury lines, even the very weak ones, were present after 9¼ hours' sparking.

I have been trying to check this work of Smits and Karssen, using a tube of similar construction, the dimensions, however, being smaller, as the amount of lead used was only 180-200 gm., and the bore of the tube where the arc was burning was ¼ in. The sparking method was first tried with an evacuated tube for 14 hours, with a current in the short-circuited tube of 60-75 amp., plus 21¼ hours with 80-90 amp. The lead was found to be pure by spectroscopic examination before the run started, and the spectra throughout the experiment, mostly photographed at 5-hour intervals, showed no mercury or thallium lines.

After a breakdown of this tube, a new run was started with new lead which, however, on very good spectrograms, showed slight traces of mercury and thallium. This time the arc was burning in ¼-½ of an atmosphere of nitrogen. First, an experiment with continuous current was performed for 25 hours, with current densities from 15 amp. to 25 amp., the latter value being maintained for 10 hours at about 38 volts. No appreciable change in the intensity of the mercury and thallium lines could be detected. The sparking method was again tried with nitrogen filling, without changing the construction of the tube or touching the lead. No mechanical devices were necessary, since the arc under a certain pressure and with a certain amount of lead present, will make and break itself as soon as the lead surfaces are brought to contact. This way of sparking should be very effective, as the arc runs through all stages of burning. After a 10 hours' run with 65 amp. to 95 amp. was performed, the scheme of connexions was changed, putting a condenser across the terminals, and a big inductance in series with the tube to protect the generator against transients. The current in the arc was now increased to 120 amp. short-circuited, and was about 60 amp. when the arc broke. With this arrangement a 12 hours' run was performed, but no increase in the strength of the mercury or thallium lines could be detected. The actual burning time of arc was a little less than half the time, and the number of contacts ranged around one a second. On increasing the current up to 150 amp., the tube broke after 2¼ hours' run.

As will be seen, the currents compare with, and even exceed, those used by Smits and Karssen, and as the dimensions of the tube are smaller the actual current densities are higher. On account of the smaller amounts of lead used, the expected products of transmutation should be more easily detected, but in spite of these two favourable conditions no transmutation could be found.

It is the author's intention also to try out the second method by which Smits and Karssen claim to get positive results, namely, high potential discharges between lead electrodes in carbon disulphide.

L. THOMASSEN.

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The Floods at Memphis.

THE news of the dangerous floods at Memphis, Tennessee, inevitably invites a comparison with its Egyptian namesake. The modern town was laid out in 1819 (soon after the evacuation of the surrounding territory by the Chickasaw Indians) by three men, John Overton, Andrew Jackson, and James Winchester, who gave it the name of the most ancient of the great capitals of Egypt because of the similarity in the geographical positions of the two sites. They realised that the American site enjoyed an advantageous position at the head of the navigable waters of the Mississippi, and from that they doubtless hoped—and time has amply justified their hope—to derive the great commercial future for their new city which a like position at the apex of the Nile Delta had secured for Egyptian Memphis throughout a period of three thousand years.

It seems possible, however, that the founders of the town had forgotten the implicit warning of Herodotus, who made his headquarters at Memphis when he visited Egypt in the latter half of the fifth century B.C. Speaking of the foundation of that city in the dim beginnings of Egyptian history, he tells us (as the priests had told him) how the river had originally flowed right under the western cliffs—as it might be the Chickasaw Bluffs in Tennessee—and how, in order to secure a larger area of low-lying irrigable land, the reigning king dammed the Nile and turned it into the middle of the valley between the two desert ranges, and then let it rejoin its bed at the apex of the Delta. He goes on to say that "to this day" (his day) the point at which the river was thus bent out of its old course was guarded by the Persians—then ruling Egypt—"with the greatest care," and was strengthened every year. "*For if the river were to burst out at this place, and pour over the mound* (i.e. *the dam*), *there would be danger of Memphis being completely overwhelmed by flood.*"

We have no exact information as to the nature of the defences thus so carefully manned by the Persians, though we may feel tolerably certain that they consisted simply in the earth banks which are almost as old in conception as the Nile mud itself and are still to be seen throughout the length of Egypt to-day. But the Greek historian's account has been verified and very happily supplemented by modern excavation. Herodotus tells us of a "camp of the Foreigners." Sir Flinders Petrie, who dug at Memphis for several years before the War, guessed that this referred to the mixed levies of the Persians; and in his first season's work he struck a building which, as he had calculated, turned out to be this very camp. It lay on the south-east edge of the town, precisely where we should expect to find the “army of occupation” whose main business was to secure the city from flood. Memphis was at this time the commercial centre of Egypt as well as being its capital, and it was natural that the Persians should keep a strong armed force in this outpost of their empire. The size and heterogeneous nature of this force is attested by large numbers of small terracotta figures representing men of all nations, from the Scythians on the north-west to a Mongolian type coming from farther India, thus indicating the extreme limits of the Persian sway. The Egyptian, we know, was from the earliest times fond of caricature, and these figurines, though showing the influence of the Greek artists then fashionable in Egypt, are definitely the work of native craftsmen. An interesting feature is the absence of women among the foreign types, although *Egyptian* women occur fairly frequently. The explanation is clear enough. Memphis had become for a time the Cologne of Egypt—if one may be permitted the anachronism—and the army of occupation, consisting of units many of whom were thousands of miles from their native lands and who doubtless despaired of seeing their own homes again, followed the natural course and took wives from among the native women. That these should in their turn become a butt for the jesting hands of their fellow-countrymen is not surprising. Thus to the bald remarks of the ancient historian archæology has added such convincing details as these models of the very soldiers, whose ‘foreign service’ for a considerable period was the comparatively ‘light fatigue’ of patrolling and repairing the dams of Memphis.

Such a strict watch was still kept up at every Nile flood until a few years ago, when the irrigation works of the British engineers put the water under more perfect control, and thus practically removed the danger from flooding. Centuries of experience of the vagaries of the Nile floods, and perhaps a cautious instinct inherited from those earliest days of human occupation of the Nile valley, when every acre of cultivable land had to be won from Nature with great hardship and risk, must have made the Egyptians more than usually careful of their dykes. At all events it is interesting to note that throughout the five millennia of its history, during which we frequently hear of looting and partial destruction by conquering armies, there is no record, so far as I am aware, of the flooding of the town of Memphis. Yet its modern namesake, although advantageously situated on the hills forty feet above the river, and in spite of all the resources of modern science, is suffering this grievous calamity little more than a century after its foundation.

S. R. K. GLANVILLE.

Biological Fact and Theory.

TEMPTING though it is to deal with Prof. Huxley's personal references to myself and others, as they have no bearing upon the argument, I would return to my protest against his dogmatic statements about doubtful matters.

Among “the fundamentals of genetics to date” (NATURE, Mar. 5, p. 350) Prof. Huxley gives “the proof that the chromosomes carry the genes, and that the genes are arranged in linear order,” and “the individuality of the chromosomes.” The ‘genes’ are of course the factors of Mendelian heredity. I think I am right in saying that they are assumed to be small particles arranged in regular order in the chromosomes, each representing a particular character. Also it is apparently assumed that *all* characters are represented by genes.

Now the usual mode of distribution of the chromosomes between dividing cells before fertilisation, provides a perfect mechanism for the distribution of the ‘genes’ according to the ‘Neo-Mendelian’ theory, but this mode of distribution is not universal in connexion with fertilisation, as I have already pointed out (NATURE, Jan. 29, p. 161). The continuous individuality of the chromosomes from generation to generation of cells and whole organisms may be a fact in some cases, but is very doubtful in others. They appear only during the process of mitosis in most organisms. Several investigators of repute (*e.g.* Child, *Biol. Bull.*, vols. 12, 13, 1907; vol. 18, 1910; vol. 21, 1911) claim that amitosis occurs among the cells destined to produce gametes. Personally, I think there is some other explanation than amitosis for these appearances, but until this and the other points to which I have referred are demonstrated, the individuality of the chromosomes must remain as an attractive working hypothesis.

While in breeding experiments certain groups of characters do appear in the individuals of consecutive generations in the Mendelian manner, the great majority of characters are common to all the individuals of a race or even many races, and any such mechanism as is provided by the chromosomes for the distribution of Mendelian characters would prove an obstacle were these common characters represented by unit factors arranged in regular lines in the chromosomes. Moreover, certain breeding experiments suggest that similar characters (*e.g.* colour) may blend when races geographically widely separated are crossed, but segregate in the case of local variants (Prout and Bacot, *Proc. Roy. Soc.*, B, vol. 81, 1909; *Entomologist's Record*, 15 and 16, 1906; *Trans. Entomol. Soc. Lond.*, 1906; *Proc.*, 1907). Blending of such important characters as the number of the vertebræ occurs in crosses between *Salmo salar*, *trutta* and *fario*. The progeny are fertile and there is apparently no segregation (Walker, “Hereditary Characters,” 1910). “Very frequently, if not always, the character that has once been crossed has been affected by its opposite with which it was mated and whose place it has taken in the hybrid,” and “Everywhere unit characters are changed by hybridism” (Davenport, “Inheritance in Poultry,” p. 80, 1906). Many other instances might be cited.

The theory seems to me the most probable which requires least in the way of assumption. That recent variations are transmitted in the Mendelian manner; that they are always tending to blend more and more if they are preserved from generation to generation; and that racial characters, derived originally from individual variations, are produced through the general potentialities of the cell for development within definitely-restricted limits, seems to me to require less in the way of assumption and to agree more easily with known facts than what is now put forward as the “Neo-Mendelian Chromosome Theory.”

That the chromosomes are concerned in the transmission of the potentialities for developing Mendelian characters is an attractive and probably useful working hypothesis, and so long as Prof. Huxley and “the whole body of those engaged upon genetical research” treat this and the other hypotheses involved as useful “conceptions and theories” (as he now calls them, NATURE, April 30, p. 639) and not as ‘laws’ and proven facts, no one can complain.

“If therefore the Reader expects from me any infallible deductions, or certainty of *Axioms*, I am to say for myself, that these stronger Works of Wit and Imagination are above my weak Abilities. Wherever he finds that I have ventur'd at any small

Conjectures, at the causes of things I have observed, beseech him to look upon them only as *doubtful Problems*, and *uncertain Ghesses*, and not as unquestionable Conclusions, or matters of unconfutable Science" (Robert Hooke, *Micrographia*, 1665 (Preface)).

CHARLES WALKER.

The University of Liverpool,
May 4.

The Coat of Sheep.

THE letter under this title, by Prof. J. Cossar Ewart, in NATURE of Mar. 19, contains some observations so divergent from those we have made here that it seems desirable to contrast the two. He remarks: "From an investigation which has been in hand for some time on the structure of the fibre forming the coat of sheep, it has been ascertained that in sheep, as in man, the first coat consists entirely of simple pithless fine-wool fibres." In the course of investigations on South African sheep and wool, I have procured a fairly complete series of fœtuses of the Merino, blackhead Persian, Afrikander, and Karakul, as well as of the Angora goat; and in each case microscopic sections have been made of the different stages in the development of the hair and wool. In view of the statement that "the first coat consists entirely of simple pithless fine-wool fibres," a re-examination has been made of all this material.

Prior to the extrusion of any fibres, apart from the coarse stiff ones over the lips, eyelids, and tip of tail, the appearance of the fœtal skin in sections is much the same in all the types. The hair plugs vary much in depth within the dermis, and keratinisation first appears within the deeper and thicker follicles. Likewise the fibres from these are the first to reach the surface, and break through the outer cuticularised layer of the epidermis. For a short time after the extrusion only the tips are visible, and the degree of differentiation is so small that little distinction can be made between hair and wool. Later, when an external difference is apparent, the outer fibres are in every case the stronger and the inner are the finer. Moreover, in transverse sections of the skin the stronger fibres often reveal a medulla, while the fine fibres are solid. Fortunately, no uncertainty exists in the recognition of the medulla in sections, though its early stages are difficult in the extruded fibre. I have already shown (Duerden, J. E., and Ritchie, M. I. F., "Development of the Merino Wool Fibre," *S.A. Jour. Science*, vol. 21, 1924) that in the Merino it arises from the hair germ as a direct upward continuation of the basal layer of the epidermis, and its cells undergo keratinisation later than those of the cortex, cuticle, and inner root-sheath; stained in picro-carmine they are a brilliant red, surrounded by the clear yellow cortex.

On account of the evolutionary loss of most of the hairy fibres in such fine-woolled sheep as the Merino, and the feebleness of the medulla in those which remain, the distinction between hair and wool is not strongly marked. The blackhead fat-rumped Persian, now so plentifully farmed in South Africa for its superior mutton, however, has a covering altogether resembling that of wild sheep, namely, an outer hairy coat and an under woolly one; and it may therefore be taken as representative of the ancestral condition of all sheep. By the time differentiation of the fibres is established in the fœtus the coarse, hairy, medullated fibres are found to project much beyond the fine wool, and there can be no question of the coarser fibres having appeared first.

The long stiff fibres of the lips and eyelids remain for the most part non-medullated until towards the close of fœtal life when, with increasing diameter, a pith develops; so that these fibres, the first to protrude, are truly hair, not wool. The morphological value of a fibre can scarcely be estimated before its growth is completed.

The results may be summarised as follows. The coarse medullated hair of the sheep and the fine non-medullated wool appear on the fœtus at about the same time, the stronger fibres slightly in advance of the finer. In fine-woolled sheep the distinctions between the two sets of fibres are not pronounced in the early fœtus, and the entire coat may have a semblance of wool; but towards the end of fœtal life a medulla appears in the stronger fibres, thus marking them off as hair, and as representative of the ancestral outer hairy coat. In wild and coarse-woolled sheep the distinction between hair and wool is apparent much earlier, and the growth of the hair throughout is in advance of that of the wool.

J. E. DUERDEN.

Rhodes University College,
Grahamstown, South Africa.

Chemical Formulæ of Mineral Compounds.

DURING the last decade I have accumulated some new facts which I believe are of fundamental significance. Certain theoretical considerations require that the chemical formulæ of *all* true mineral species composed of any of the first twenty-one elements of the periodic system should obey the following simple equation:

$$M = 2a + 8n,$$

where M is the molecular number (*i.e.* the total atomic number in the compound), a the number of atoms, excluding hydrogen, and n any integer.

My first notes, based on Dana's "Text-book of Mineralogy" (1912), recorded five exceptions to the above equation, disregarding four substances of organic origin. Later I verified that Dana (1922 edition) corrected the formulæ of aluminite and lazurite, leaving me with three exceptions only. Afterwards I obtained from other sources the corrected formula $(Na_2,Ca)O . Al_2O_3 . 5SiO_2 . 10H_2O$ for faujasite and $CaMg_3(SiO_3)_4$ for tremolite, which left tavistockite as the sole exception for some time. Mellor's "Inorganic and Theoretical Chemistry" (1923) mentions the latter as $Al_2Ca_3(OH)_6(PO_4)_2$, which is in perfect harmony with my equation. Granting the correctness of this formula, my list of exceptions is now reduced to merely four organic minerals—whewellite, oxammite, mellite, and fichtelite. These, however, were expected and bear a theoretical significance which cannot be discussed here. I have been able to cover most of the remaining minerals by a modification of the above equation based on a new theory, the satisfactory completion of which involves difficulties which I hope to overcome.

L. W. TIBYRIÇÁ.

Caixa 1330,
São Paulo, Brazil,
Mar. 25.

MR. TIBYRIÇÁ's formula, which amounts to the statement that $M - 2a$ is divisible by 8, may be interpreted in the following manner. Every atomic number of the elements from 2 (helium) to 21 (scandium) may be represented by the expression $2 + 8d + v$, where d is an integer from 0 to 2 and v an integer from 0 to 4, equal to the valency of the element. This is supposed to be due to the arrangement of the electrons in layers; the first complete layer consisting of two, the second and third of eight electrons each; the valency being an excess above or a deficit below a complete layer. The elements with $+v$ are often described as positive, those with $-v$ as negative. In any compound of two atoms in which the atomic number of one contains $+v$, and that of the other contains $-v$, the total 'molecular number,' M, will be $2 \times 2 + 8(d + d')$, where d and d' may be the same or different. Similarly, in a compound containing a atoms, with the sum of the + valencies equal to that of the − valencies, the total molecular number will be $a \times 2 + 8(d + d' + \text{etc.})$, where $(d + d' + \text{etc.})$ is an integer n. This is Mr. Tibyriçá's formula. In minerals, which are compounds, consisting only of elements with numbers from 2 to 21, all combination is between elements with + valency (including for this purpose the tetrads) and those with − valency, and their valencies are all satisfied. The only exception of which I am aware is carbon monoxide, which undoubtedly exists in a natural state.

So far, the element hydrogen has been left out of consideration. Its atomic number, $2 + 8 \times 0 - 1 = 1$, satisfies the same conditions as do the other elements up to 21, but though it has a − valency of 1, it behaves as an element with + valency and combines with elements with − valency, instead of those with + valency; thus water or ice would not satisfy Mr. Tibyriçá's formula. For $M - 2a = 2 + 8 - 6 = 4$, which is obviously not divisible by 8 If the elements of an even number of molecules of water be present in a molecule and the other elements present satisfy the formula, the mineral as a whole will do so. But if only the elements of an odd number of molecules of water be present, it will not. Thus, if tavistockite have the formula $Al_2Ca_3(OH)_6(PO_4)_2$, Mr. Tibyriçá's formula would not apply. For $M = 234$ and $2a = 54$; so that $M - 2a = 234 - 54 = 180$, which is not divisible by 8. But it appears that in calculating the number of atoms, a, he does not include atoms of hydrogen, though he includes their atomic number in calculating M. Consequently for water $M - 2a = 2 + 8 - 2 = 8$; so that for minerals with an odd multiple of the elements of water, $M - 2a$ is still divisible by 8.

J. W. E.

Progressive Lightning.

I HAVE read with interest Prof. Boys's comments on the phenomena of "Progressive Lightning" in NATURE for Feb. 19 last. The object of this present note is to direct attention briefly to some considerations in connexion with that phenomenon which occurred to me after writing my note of Dec. 19, and do not appear to have been discussed so far as I know, and to clarify and supplement some points brought out by Prof. Boys.

At the outset I must say that I have made no especial studies of these phenomena, but have simply observed them as one interested in all Nature. The generally accepted explanation of the multiple flashes as progressive discharges through a channel rendered a better conductor by the preceding discharge, was seemingly so sound and reasonable that it was a profound surprise to note what appeared to be different behaviour of the near flashes. I would be glad to supplement my visual observations by photography, but that is impossible. I have more investigations in hand now than I can finish, and my experience has invariably been that even an apparently simple problem reveals so many by-paths and requires so many subsidiary investigations that it becomes a major one before a solution is reached—if ever.

Prof. Boys's observations of close-by multiple flashes seems to set at rest the question of the phenomena depending only upon distance, as my observations seem to indicate. He quite properly raises the point of a near flash blinding the eye to subsequent ones. In my own case this can scarcely be the explanation of the failure to observe multiplicity in the near-by flashes, because many of those very close were not seen directly but by their general illumination, which is not sufficiently blinding and would not prevent noting subsequent ones. Many were also observed in day time, when blinding is much less likely to occur. Certainly a negligible number of my observations could have been so affected.

After sending my former note another fact impressed me, namely, that the general glare accompanying distant flashes appears also to be of greater duration than those near by, about in the same ratio as the flashes themselves. This is very difficult to explain on almost any hypothesis. Ordinary refraction or reflection phenomena alone appear inadequate, as the great velocity of light would limit such effects to a negligible fraction of a second.

It may be urged that there will be a persistence of such phenomena so that the duration will appear sensible. There is no reason, however, that I can see, why such persistence of vision should be greater in distant than in near flashes.

While I feel some confidence in the reality of the difference between near and distant flashes observed here, I also feel that it should be confirmed by photographic observations before considering it as established, because of Prof. Boys's observations of multiplicity in near-by flashes and because of theoretical objections. I should hesitate to believe that there was any essential difference in such phenomena here and in England, for example, without further evidence.

I have considered only discharges of lightning to earth, because discharges between clouds seemed to present some anomalies.

C. D. PERRINE.

Observatorio Astronómico de la
Nación Argentina,
Cordoba.

BEING essentially an experimentalist, I am of opinion that the subject of "Progressive Lightning" is one for experiment rather than discussion, and that the simple apparatus for causing two images to move at equal speeds upon the photographic plate but in opposite directions so as to obtain opposite aberrations, which I described in NATURE of Nov. 20 last, is likely to give direct information as to fact. Dr. Simpson has this now, and I am hoping that the experiment may be made also in America, where the method has attracted some attention.

C. V. BOYS.

Rotation of Dielectric Bodies in Electrostatic Fields.

REFERRING to the letters by the late Dr. S. W. Richardson and by Mr. G. L. Addenbrooke in NATURE of Feb. 12 and Mar. 12 respectively on the rotation of dielectric bodies in electrostatic fields, the following may be of interest.

We have recently observed that if the metallic points of a Hamilton reaction mill or 'electric whirl' are replaced by dry wooden points, the normal direction of rotation is reversed; that is to say, instead of rotating in a direction *opposite* to that toward which the points are directed, the mill with wooden points rotates in a direction the *same* as that toward which the points are directed. The cause of the rotation under these conditions must then be quite different from that when metallic (good conducting) points are used—where the explanation is that ions are produced in the immediate vicinity of the point by the process of ionisation by collision, those of *opposite* sign to the charge on the point are nmediately drawn into it, those of the *same* sign are epelled, and that the rotation is due to the mutual epulsion between the swarm of latter ions and the harge on the point.

It is interesting to note that a wet point (we used rdinary matches for points) will rotate in the normal irection at first, then, as it dries, decrease its speed, ome to rest, and finally begin to rotate in the pposite direction.

Rectangular blocks of paraffin mounted nonymmetrically on the arms of the mill (two straight rass arms were used mounted on the head of an rdinary speedometer connected to one pole of a large Ioltz machine, the other pole being connected to a lane wire netting suspended in a horizontal plane bove the rotating arms and parallel to them) ehaved in a similar manner to the dry matches, .e. rotated in the direction toward which the greater art of the block protruded. In the dark in the latter ase, extensive brushes could be seen on the arms near he paraffin, and there is no doubt that the action of he block is to form a non-symmetrical brush, which rives the arms much the same as the brush from a netallic point drives it. The brush, of course, is ormed on the side of the block which protrudes least rom the arm in the plane of rotation.

In the case of the matches the cause of the rotation s not so clear. Only a faint glow can be observed on he end of the match. It seems likely, however, that he action of the dry match is to disturb the faint silent) discharge from the arms of the mill, retarding t on the side toward which the match protrudes, so hat the major portion of the brush forms on the side f the arm opposite to the match and so drives the rm in the direction toward which the match extends. This point is still under investigation.

A. W. Simon.
J. M. Cage.

California Institute of Technology,
Pasadena, California.

Yolk Formation in some Arthropods.

There has recently been controversy between Harvey on one hand and Gatenby and Vishwa Nath on the other, as to the relationship of Golgi apparatus and mitochondria to yolk formation.

I have been myself engaged on this particular problem for the last year or so. A brief account of a portion of my work in collaboration with Dr. Vishwa Nath was published in Nature of Nov. 6, 1926. I have since then worked out three more arthropod forms, namely, *Musca domestica*, Forficula and Porcellio. The relationship of yolk formation to the cell inclusions may be described as follows.

In Musca the nucleolus divides at a very early stage and the various nucleoli begin to fragment. These fragments soon escape into the cytoplasm but do not undergo any further fragmentation. Simultaneously with the escaping of these extrusions, a fuchsinophil yolk arises in masses all over the cytoplasm. In Scolopendra (Nath and Husain) a similar though not identical relation has been noticed between this yolk and the extrusions. In Forficula the fragmentation of the nucleolar extrusions has been followed in most eggs. In Porcellio, the nucleolus does not fragment at all, and it is interesting to note that there is no proteid yolk in this form.

In all three cases both the Golgi apparatus and mitochondria have been observed. The latter are always granular and never filamentous. They are seen to divide but never swell up into yolk of any kind. The Golgi apparatus is seen as a juxta-nuclear mass in the younger eggs of all forms. It is always in the form of dots and dashes and never discoid. It does not arise *de novo* in the cytoplasm but is formed by the multiplication of the pre-existing Golgi elements. In Forficula and Porcellio, free fat arises directly by a metamorphosis of the Golgi apparatus. In Musca the latter never swells up, and in correlation with that it is interesting to note that there is no fatty yolk in this form.

A detailed account will be published later.

Mian Tasdiqur Husain.

Department of Zoology,
Government College,
Lahore (Punjab),
April 11.

Soft X-ray Spectra.

Although much general information of soft X-ray spectra can be obtained by photoelectric methods, there is an urgent need for its direct spectroscopic confirmation. Dauvillier (*Jour. de Phys. et le Rad.*, 8, 1; 1927) has recently photographed some lines of boron, carbon, oxygen, and thorium between 25 Å.U. and 125 Å.U. by refined methods of crystal spectrometry. Spectra in this region can also be obtained from a concave glass grating if it be mounted at a sufficiently large angle of incidence.

Using the anticathode of an X-ray tube as a source of radiation, I have, by this method, obtained photographs of some fifteen lines between 40 Å.U. and 200 Å.U. Their interpretation requires some care, since, in general, the same lines appear whatever the nature of the anticathode. The *K* line of carbon (44 Å.U.) is present on all plates, though in varying intensity, due presumably to the destruction of residual vapours in the tube. The *L* lines of carbon and the *K* and *L* lines of oxygen and nitrogen fall outside the region covered by these experiments; as possible causes of the observed spectra there remain strontium, barium, and platinum deposited from the filament on the cold anticathode. Perhaps the most prominent of the lines which have so far been fitted into the scheme of X-ray levels is the $M_{\text{I, II}}$ doublet of strontium ($\lambda = 159$, 160·1 Å.U.). A few lines appearing faintly on the photographs seem to be due to the anticathode itself—lines associated with the *M* levels in the case of zinc, copper, and iron.

A curious feature of the spectrum of aluminium is the presence of a kind of band, with a sharp limit at 166·6 Å.U., shading off towards longer wave-lengths. It appears to be not without structure, though this cannot be definitely asserted until further experiments have been performed.

It is worth mentioning that spectra in this region can also be obtained from a grating of speculum metal, though with considerable difficulty; and that Schumann plates are at least fifty times as sensitive as X-ray plates, even though they are treated with a fluorescent oil.

T. H. Osgood.

Ryerson Physical Laboratory,
University of Chicago, April 11.

Consideration of Six Cases in Zoological Nomenclature.

The Secretary of the International Commission on Zoological Nomenclature has the honour to invite attention of the zoological profession to the fact that application for 'suspension of the rules' has been made in the six following cases:

I. *Odontaspis* Agassiz to be retained with *Carcharias taurus* Rafinesque as type.

II. *Eulamia* Gill to be retained for *Carcharias* Mueller and Henle (not Rafinesque, 1810).

III. *Carcharodon* Mueller and Henle, 1838, to be retained.

Cases I., II., and III. would involve treating Rafinesque's Caretteri (April 1810) and his Indice (May 1810) as two parts of one and the same paper.

The rigid enforcement of the rules would retain *Carcharias* vice *Odontaspis*, *Eulamia* vice *Carcharhinus*, and *Carcharhinus* vice *Carcharodon*.

IV. In *Aëtobatus*, *Raja* (*Aëtobatus*) *vulgaris* to be understood as *Raja aquila*, for which it was obviously intended. This replaces *Myliobatis* Cuvier and leaves *Stoasodon* for *narinari*.

V. Suppression of "Synoptisches Verzeichnis . . . der Baikalflohkrebse" in *Bull. Internat. Acad. Pol. Sci. et Let.*, 1926, pp. 1-77, from nomenclatorial consideration. Examples of generic names used: *Siemienkiewicziechinogammarus*, *Cancelloidokytodermogammarus*, *Loveninuskytodermogammarus*, *Parapallaseakytodermogammarus*.

VI. *Lithostrotion striatum* Fleming, 1828, to be declared genotype of *Lithostrotion*, in place of *L. floriforme* designated by Edwards and Haime, 1851.

Zoologists interested in these cases are cordially invited to communicate their views to the Commission not later than Jan. 1, 1928.

C. W. STILES.
(Secretary.)

U.S. Public Health Service,
Washington, D.C.

Odours and Visual Imagery.

THE relative inhibition of cortical brain functions and the progress of uncritical activities, such as imagery, during the initial and terminal phases of sleep (cf. NATURE, Aug. 7, Sept. 11, and Oct. 30, 1926), may find a parallel in certain cases of visual imagery induced by odours. The following illustration may be of interest. A small bottle containing methyl salicylate was associated consciously and deliberately with a number of circumstances in which some experiments had been carried out three or four years ago. On withdrawal of the stopper, the odour induced a visual image of a medical practitioner in a bedroom, merging into the image of a table with a tumbler of water and a spoon. Afterwards, the image, or images, were found to be as blended as the content of a dream, since the room, the doctor, and the table, had to be referred to widely separated times and places. *Litera odorata manet.*

The similarity between such a smell association and dream phenomena calls to mind the argument put forward by Dr. Halliday (*Glasgow Med. Jour.*, Mar. 1926) as to the correspondence between verbal aphasia conditioned by deterioration of the neopallium and the natural aphasia as regards names for smells, due to the absence of higher integrating levels in the archi-pallium.

The above considerations, together with numerous records of smell associations, reinforce a suggestion (*Brit. Med. Jour.*, 1922, i. p. 904) that odours should be used in psycho-analytical practice. In the treatment of neuroses on analytic lines, the overcoming of a high resistance in certain patients by means of images recalled by olfactory stimuli has been found recently to be of some considerable practical value.

J. H. KENNETH.

The Homestead, Clynder,
Dumbartonshire, May 3.

Effect of Temperature on the Refractive Index of Rocksalt.

WE are writing to direct attention to a source of error which may occur in spectroscopic investigation of the infra-red region of the spectrum. On reviewing the literature in which experimental work in this region is reported, we find that usually no note is mad of the temperature of the prism at the time when th experiment is being conducted. In the course o investigations which we have been carrying on fo some time on the absorption of gases in the near infra red, we have had occasion to observe the importan effect of temperature on the refractive indices o rocksalt and fluorite. Thus, a variation of 5° in th working temperature would result in a difference of s much as 0·075μ (about 180 wave numbers) in certai parts of the near infra-red.

The commonly adopted practice of accepting th 4·4μ emission band of carbon dioxide, or the quart reflection bands, as bench marks is misleading unles combined with suitable temperature corrections o the prism used. It is our intention in the nea future to deal with these matters fully and to describ the procedure we adopt to ensure greater accurac in the determination of infra-red bands with pris apparatus.

R. ROBERTSON.
J. J. FOX.

Government Laboratory,
Clement's Inn Passage,
Strand, London, W.C.2, May 17.

The Industrial Revolution.

MISS BUER, in NATURE of May 7, p. 671, is, I think, under a wrong impression in stating that the use of Newcomen's engine (in England) was not widespread. Statistics are not available, but in 1769, John Smeaton obtained a list of 99 engines that had been erected in the Newcastle-upon-Tyne district alone. Pryce, in "Mineralogia Cornubiensis," 1778, gives the figure for Cornwall as 60 at that date. We have to reflect that the materials of one such engine might cost £1000, and its annual upkeep £200.

Nor is there any evidence that the engine "was frequently abandoned owing to the wasteful consumption of fuel." The engine was only applicable to pumping, and its largest sphere of usefulness was at collieries, where fuel consumption was scarcely a consideration at all. An engine was abandoned or transferred when a mine was given up. Far from being 'experimental,' as suggested, the longevity of these engines was sometimes extraordinary, *e.g.* the one in the Science Museum, South Kensington, was in service for more than a century and a quarter.

H. W. DICKINSON.

The Science Museum,
South Kensington, S.W.7.

Hardness of Metals in Relation to Periodicity.

IN Mr. Mallock's letter (NATURE, Feb. 19, page 276) he states that the periodicity of the hardness he determined does not fit Mendeléef's table. It is interesting to note that the hardnesses, and incidentally also the melting-points, fit rather well into the 18-period spectroscopic table which will be found on page v of the appendix of "Astronomy," by Russell, Dugan, and Stewart. Inspection will show that the hard and soft metals are grouped and differentiated, and sequences with rather well-defined maxima and minima may be observed.

A possible interpretation lies, I believe, in the electronic configuration of the atom in question. Those with the complete electron shells, as for example the rare gases, have low melting-points, whereas those with the shells about half complete, such as tungsten, osmium, and carbon, are the hardest, and with highest melting-point.

S. A. KORFF.

Princeton University,
New Jersey, May 4.

The Progress of Hittite Studies—I.[1]

By Prof. J. GARSTANG.

THE remarkable development in Hittite studies, which the circumstances of the War tended to obscure, now merits the attention of all students of history. This progress is due not so much to the results of excavations or further exploration, interesting though these be, as to the decipherment of an important section of the Hittite archives from Boghaz-Keui which opens the doors to more than one library of contemporary documents. The clue was found and established on an Indo-European basis, by Prof. Hrozný of Prague in the early years of the War. Since then a circle of eminent German philologists (amongst whom may be mentioned Drs. Weber, Forrer, Weidner, Figulla, Götze, as well as Profs. Friedrich, Sommer, Zimmern, and others) has placed the new study on a scientific basis by the continuous publication of texts and transcriptions no less than by philological and critical discussion. A new light plays upon Asia Minor under the Hittite kings.

It is both interesting and instructive to look back at the origins of the subject. The Hittites have long been known, from the numerous references in Biblical literature, either as scattered settlers in Palestine or as military peoples in the north of Syria. The latter impression was confirmed, from the time when Egyptian hieroglyphs came to be understood, by scenes and inscriptions on Egyptian temple walls depicting the conflicts of the Pharaohs with this war-like rival, whom they encountered in Syria and called Ḫ-t-Ꜣ. Two generations ago Dr. Wright hypothesised that certain unexplained hieroglyphic inscriptions found at Hamath and elsewhere in northern Syria must pertain to the same peoples. French scholars and others adopted the idea, and it was recognised that the distribution of such inscriptions was not confined to Syria; but that ruined cities, religious sculptures, and numerous groups of pre-Hellenic monuments bore witness to the same culture-influence in Asia Minor itself. Then Prof. Sayce, who lives to see the verification of his far-sighted conclusions, after examining and comparing certain inscribed sculptures on the western coast near Ephesus, constructed his theory of a long-forgotten Empire of the Hittites, whose kings held dominion over Asia Minor and played their part in oriental history so long before the fall of Troy that their memory scarcely survives in Homeric legend. It was these kings who descended from beyond Taurus and battled with the Pharaohs in the fourteenth and thirteenth centuries B.C.

A theory so comprehensive, albeit plausible, was naturally followed by a period of reactive scepticism and investigation. It suggested, none the less, the lines of practical research. British explorers and scholars, notably Ramsay, Hogarth, Anderson, and others, joined in the quest: new materials were found and cautiously examined. Early in this century English and American universities (Liverpool, Cornell, and Princeton) organised expeditions to collate materials and collect new data. Asia Minor being diplomatically closed, excavations were undertaken by the Liverpool institute and by the British Museum at promising sites in northern Syria.

Meanwhile the German Orient Society had received permission to excavate among the remains of the largest ruined city of pre-Hellenic character in Asia Minor, at Boghaz-Keui, a small village in the north-east of the plateau within the circuit of the Halys River; and there Dr. Winckler, early in the work, had the fortune to discover hundreds of fragments of inscribed clay tablets, numbers of which were in Semitic and could be read. They contained names of Hittite kings and places (some of which could be recognised), names of Syrian princes known from Egyptian sources, records of campaigns and negotiations in Mesopotamia and in Syria; and, most important for history, the names of contemporary Egyptian rulers. Being present at the time, the present writer was courteously permitted to investigate the circumstances of the discovery, and shared in Dr. Winckler's anticipations. It was clear that these tablets contained imperial archives; their presence seemed to fix the royal palace there where they were found, and this was soon confirmed. The Hittite capital was called Ḫattušaš, the homeland Ḫatti. The latter was clearly the counterpart of the Egyptian Ḫ-t-Ꜣ. Not only was the Hittite Empire a reality, but the Hittite kings emerged into the full light of history, claiming their part in the contemporary events of near Asia. There remained an apparently inexhaustible supply of documents to be scrutinised, but a great proportion was found to be unintelligible though written in cuneiform script. Dr. Winckler was able, however, to publish before his death a number of the Semitic texts, chiefly concerning affairs in Syria, some of them narrating events of which parallel accounts existed from the Egyptian sources, including references to and a draft of the treaty with Rameses II. Hittite studies stood at that stage when last reviewed at the Royal Institution under the same title nineteen years ago.

It now appears from various sources that about 20,000 tablet fragments were recovered, for further discoveries were made in the next year of work. From these some 700 documents have been reconstructed and about 260 have been published. Analysis shows that, apart from the Semitic texts, six 'native' languages are involved, and of these only one, which we may call for the present 'official Hittite,' can be translated with certainty. This language is called by some Kanesic. It forms all kinds of words by suffixes, and three-quarters of its grammatical forms are to be found in Indo-European languages in the same sense. It is safe to premise at any rate a common even though remote parentage (Proto-Indo-European). Hittite names, on the other hand, are prefixing, and analogy is to be sought rather in the Caucasus. In Mesopotamia, again, the Mitannian rulers' language was seemingly Aryan with Sanscrit affinities, differing from the common language of the area, which also has Caucasian elements.

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[1] Summary of three lectures delivered at the Royal Institution on Feb. 24, Mar. 3 and 10, 1927.

The difficulty of language was evidently felt by the archivists of the time, for glossaries were compiled for the translation of unfamiliar expressions, and some documents were set out in parallel bilingual columns. The tablets were in fact the contents of royal libraries of the thirteenth century B.C., and many of them are copies of older documents that had been damaged. They cover a vast range of subjects, from imperial affairs to domestic detail. Treatises on non-political matters were so numerous as to call for a proper inventory or catalogue by the names of authors (both male and female). Among the state documents or copies of them, those of most immediate interest historically include foreign correspondence with Egypt and with Babylonia, correspondence and treaties with the Amorite chieftains of Syria and the smaller states to the north (Aleppo, Nukhašše, Barga, Carchemish, etc.); treaties with a Mesopotamian (Mitannian) prince, as well as private letters between the members of the various royal families. Happily for us to-day, a historical instinct pervaded the foreign office of the time, so that many treaties contain preambles setting forth in chronological sequence the outline of events and past relations between the contracting states or princes down to the framing of the new agreement. These prefaces contain names of old-time kings and places, records of campaigns and rebellions and former treaties. They can be checked in some cases by the prefaces to earlier or later treaties, and occasionally by allusions in documents relating to other states. They are new materials for history; and it is already possible to reconstruct and trace in outline the development of the imperial organisation, in which diplomacy and military genius play a leading part.

The earliest references to Ḫatti occur in the Babylonian records of Sargon and Naram-Sin of Agade, which take us back before the middle of the third millenium B.C. It would appear that Ḫatti was at that time one of the leading tribal areas of Asia Minor. After an interval which can only be approximated at about 500 years, the Hittite archives indicate a period of struggle for the over-lordship of Asia Minor: the first Great-King whose dominion reached to "the sea" and included Ḫatti, resided at Kuššar. Thereafter there is record of some forty-nine Hattic rulers, whose reigns cover approximately the thousand years ending with 1200 B.C. An important synchronism is found in the annals of an early King Mursil, who claims to have captured Aleppo and Babylon, and it is confirmed by the Babylonian records that this invasion brought the first Babylonian dynasty (that of Hammarabi) to an end. Unfortunately, the date of this event is not agreed on by Babylonian scholars, being variously estimated as between 1950 B.C. and 1750 B.C. Further study of the Hittite archives may help to settle that point and others connected with the Hyksos period.

When first Ḫatti became dominant among the Hittite tribes of Asia Minor, their kings continued, it would appear, to reside at Kuššar, but from the epoch of the sack of Babylon the capital is found fixed at Ḫattušaš, and so continued with possible political interruptions until the end. Aleppo claimed great power and temporary independence a century or so later, a date which may have fallen within the Hyksos period. From about 1470 B.C. onwards the records of the Ḫatti dynasty are continuous, comprising twelve consecutive reigns, some of which are described with instructive detail. Relations direct or indirect with Egypt under the eighteenth dynasty, particularly the penetration of Subbiluliuma into Syria (period of the Amarna letters), the battle between Mutalliš and Rameses II., and the treaty of Ḫattušil III. with the same Pharaoh, give a series of fixed chronological positions on which the framework of international events can be constructed.

(*To be continued.*)

Wave Mechanics and Classical Mechanics and Electrodynamics.

By Prof. G. A. Schott, F.R.S.

Recent articles in this journal by Mr. R. H. Fowler, Prof. M. Born, and Dr. P. Jordan have dealt with the relation between Schrödinger's wave mechanics and the quantum theory, but it is admitted that they scarcely express the views of Schrödinger himself or those of his predecessor, L. de Broglie. The object of the present article is to give an account of the researches of these two authors from the viewpoint of classical mechanics and electrodynamics, to which they are closely related, both in subject-matter and method. A brief bibliography of their papers, as well as a few by other writers on the same subject, is appended, to which the reader is referred for details, for an outline only of the line of thought can be given in the present article.

The root of these researches is to be found in the papers of Sir W. R. Hamilton, published a century ago, in which he pointed out the close analogy subsisting between Fermat's Principle of Least Time in optics and Maupertuis' Principle of Least Action in dynamics. Just as Fermat's Principle enables us to trace the paths of light rays with considerable accuracy when the linear dimensions of our apertures and obstacles are large compared with the wave-length of light, but fails when they are so small that diffraction becomes important, so Maupertuis' Principle enables us to predict the paths of material particles accurately so long as the linear dimensions of the paths are sufficiently large, but fails when they are of atomic dimensions. In such cases we must resort to the methods of wave mechanics.

So much being premised, we may summarise de Broglie's argument thus: every element of energy —electron, proton, or quantum—is associated with a periodic phenomenon, not specified, whose frequency is given by Einstein's equation, whether the element be at rest, or moving with uniform velocity v relative to the observer. In the latter case the periodic phenomenon at a point fixed to the moving element appears to be slowed down, like a moving clock in the theory of relativity, but at a point fixed in the observer's frame of reference it appears as a phase-wave, propagated in the direction of relative motion with the phase-velocity $u = c^2/v$. The velocities u and v are related as wave- and group-velocity respectively. Einstein's frequency equation, together with the Principle of Invariance, makes the momentum-energy fourvector of the moving element a constant multiple of the wave-vector of the associated phase-wave, whence it follows that the Action of the element is a constant multiple of Fermat's time-integral for the phase-wave, so that the Principles of Least Action and Least Time are equivalent, a result generalised by E. Schrödinger and L. Flamm.

Moreover, the quantum integrals of Bohr and Sommerfeld, being essentially Action integrals taken round closed orbits of electrons, are proportional to phase-integrals taken round rays of the associated phase-waves, which rays are identical with the corresponding orbits. Hence the quantum conditions, which state that the quantum integrals are integral multiples of Planck's Action constant h, are equivalent to the conditions for resonance between the electrons and their associated phase-waves, which state that the changes in phase of the phase-waves in passing round the orbits of their respective electrons are integral multiples of the wave-lengths.

With de Broglie the concept of the electron or other element of energy is primary, whilst that of the phase-wave is secondary, but with Schrödinger the position is reversed. In his theory the principal part is played by the so-called wave-function ψ, which determines the phase-waves and is a solution of a linear partial differential equation of the second order of the type of the wave-equation in classical mathematical physics. The electron, or element of energy, becomes merely a focus of a group of phase-waves, and in the atom, where the focus is ill-defined, it loses its individuality altogether. In order to re-establish contact with electrodynamics, Schrödinger finds it necessary to introduce a new and at first sight arbitrary hypothesis, defining the density of electric charge in terms of the wave-function, but justified by the results to which it has led at the hands of Schrödinger himself, of A. Sommerfeld and his pupil F. G. Slack, and of J. C. Slater.

Originally, Schrödinger deduced the wave-equation from a form of the Principle of Least Action suitably modified to suit a continuum of n-dimensions. He takes an integral—which we shall call I for the sake of brevity—of the form $I = \int(H - E)\mu d\omega dt$, where H is the Hamiltonian function, expressed in terms of generalised co-ordinates q and momenta p, E is the total energy, μ a suitable factor, used if necessary to make the integral invariant, and $d\omega$ is an element of extension of the q-space of n dimensions. He then replaces p by $\partial S/\partial q$ as usual, where S is Hamilton's characteristic function, puts $S = K \log \psi$, where K is a constant of the dimensions of action, and ψ the wave-function, chooses μ to be proportional to $\psi\bar{\psi}$, where $\bar{\psi}$ is the conjugate of a complex ψ, and finally makes the integral I stationary by varying ψ. This somewhat arbitrary process by the usual method yields the wave-equation. For a particle moving in 3-dimensional space it reduces to

$$\nabla^2\psi + \frac{2m}{K^2}(E - V)\psi = 0,$$

where m is the mass of the particle, and V the potential energy. In his later papers Schrödinger postulates the wave-equation once for all; it has been generalised in various ways, which need not be particularised here, by Schrödinger himself and others, notably de Broglie, L. Flamm, and O. Klein.

In general the potential energy V introduces singularities into the wave-equation, and we must seek a solution ψ, which shall be one-valued, finite and continuous even at the singularities. The conditions that this may be the case automatically select values of the energy constant E and corresponding energy levels and normal frequencies, which are alone possible for stationary processes in the system, without any appeal to extraneous quantum conditions. Thus the singularities of the wave-equation are analogous to the boundaries in such classical problems as that of the motion of a stretched string or membrane.

For example, in the problem of the hydrogen atom we have $V = -e^2/r$ in the usual notation; the singularities are $r = 0$ and $r = \infty$, and the corresponding conditions make all positive values of E possible, but only a discrete series of negative values, given by $E = -me^4/2K^2l^2$, where l is an integer. The former determine a continuous series of infinite electronic orbits; the latter a discrete series of finite orbits, agreeing with Bohr's stationary orbits, if we put $K = h/2\pi$. In order to obtain the Balmer series Schrödinger assumes that the normal frequency is approximately a linear function of E—a relation which he states is exact on a relativity theory—and deduces that the lines of the series arise from beats between normal modes of vibration simultaneously present in the atom. In later papers he solves other problems, such as those of Planck's oscillator and the rotational oscillator, and introduces a method of perturbations for the study of more difficult cases, such as the Stark effect and the problem of dispersion and resonance, but we cannot describe his results in detail here.

In his second paper, Schrodinger pursues the analogy between Hamilton's Principle of Varying

Action and Fermat's Principle of Least Time for the propagation of waves in an n-dimensional space, now using Hamilton's Principal Function $W = -Et + S$ in place of S. The surfaces $W =$ constant are the wave-surfaces, propagated with the phase-velocity $u = E/\sqrt{2(E - V)}$, and belonging to a progressive wave-motion in the q-space. The image of the mechanical system in this space, which is determined by the instantaneous values of the co-ordinates q, moves along an orthogonal trajectory of the wave-surfaces—a ray—with the velocity $v = \sqrt{2(E - V)}$, so that $uv = E$. On the assumption that the waves have a time factor $\sin(2\pi W/h + \text{constant})$ the frequency is given by Einstein's equation $\nu = E/h$, and v becomes the group velocity corresponding to the phase-velocity u, a generalisation of de Broglie's result, but obtained from classical mechanics and not from relativity. Schrödinger concludes that a group of approximately monochromatic waves, of dimensions of many wave-lengths in all directions, represents a material particle, but only when the path is large compared with a wave-length. Then Jacobi's dynamical equations show that the image of the mechanical system always coincides with that point of the q-space at which a certain continuum of waves of the group are all in the same phase, thus constituting a 'packet of waves.' A one-dimensional example of such a packet is given in Schrödinger's paper in *Die Naturwissenschaften*. But this representation by an image is only approximate and fails for atomic systems, owing to the indefiniteness of the image; in such cases the true representation of the actual mechanical phenomenon is given by the wave-motion in the q-space and this must be determined from the wave-equation.

To overcome the indefiniteness attaching to the notion of the electron in atomic systems Schrödinger defines the density of the electric charge, coupled with one of the mass-points of classical mechanics, as the integral, taken over the system co-ordinates of the remaining mass-points of the system, of the product of the classical charge of the selected mass-point by the value of $\psi\bar{\psi}$ at that point, where $\bar{\psi}$ is the conjugate of ψ, when both are complex quantities, ψ and $\bar{\psi}$ being of course normalised to unity. This hypothesis, already referred to above, is really indicated by the choice of the factor μ in the Action integral I which is clearly proportional to the material density in the q-space, though Schrödinger apparently makes no mention of this connexion. Since it gives results in accordance with experiment and, moreover, agrees with the relativity definition of the electric current vector, there is a good deal to be said for it.

In conclusion, it need only be said that Schrödinger's wave-equation method has already yielded results including and even transcending those obtained by the various quantum theories, and offers a fair prospect of explaining quantum phenomena by means of the methods of classical mechanics and electrodynamics.

Bibliography.

L. de Broglie: *Phil. Mag.* (6), 47, 446; 1924; *Ann. de Phys.* (10), 3, 22; 1925; *J. de Phys.* (6), 7, 321; 1926; *ibid.* (6), 8, 65; 1927; *C.R.*, 184, 81; 1927; "Ondes et Mouvements," 1926.

E. Schrödinger: *Ann. der Phys.* (4), 79, 361, 489, 734; 1926; *ibid.* (4), 80, 437; 1926; *ibid.* (4), 81, 109; 1926; *Die Naturwissenschaften*, 14, 664; 1926; *Phys. Rev.*, 28, 1049; 1926.

L. Flamm: *Phys. Zeitsch.*, 27, 600, 733; 1926.

P. Debye: *Phys. Zeitsch.*, 28, 170; 1927.

A. Sommerfeld: *Phys. Zeitsch.*, 28, 231; 1927.

O. Klein: *Zeitsch. f. Phys.*, 41, 407; 1927.

F. G. Slack: *Ann. der Phys.* (4), 82, 576; 1927.

J. C. Slater: *Proc. Nat. Acad. Sci.*, 13, 7; 1927.

Obituary.

Prof. G. O. Sars.[1]

The name of Georg Ossian Sars, who died on April 9 at eighty-nine years of age, has been classic to every marine zoologist for three generations—indeed since the elder, Michael Sars, then a clergyman at Florö in western Norway, published his "Beskrivelser og Jagttegelser" (1835), followed by other important memoirs which by and by led to his appointment to the chair of zoology in Oslo (Christiania) in 1854. Born in 1837, Georg Ossian Sars had the priceless example of a distinguished father and a sympathetic home, where his innate enthusiasm for marine zoology was welcomed and encouraged in no ordinary degree. Thus from early youth onward almost to his ninetieth year, the talented brain and hand unceasingly laboured at his cherished subject with a success almost unrivalled in modern times.

After a careful training in the schools of Bergen and Christiania, Sars entered the University of the latter city, where he distinguished himself in geography and natural history, finally receiving a gold medal for his researches on Crustacea. His original contributions to marine zoology thereafter began with a paper on the Cladocera in the 'sixties of last century, and by and by ranged over the whole field from Protozoa upward, so that he has left a remarkable record.

When still a young man (in 1864), Sars became a member of the Fisheries Scientific Research Committee and had facilities for studying the development of the cod off the Lofoten Islands (where his father had worked before him) on the north-west coast of Norway. He found that the cod, contrary to the general opinion, spawned in midwater, and that the eggs were pelagic, that is, float in the water, as a rule—indeed, keeping near the surface—as likewise do the newly hatched larvæ; and so with the haddock, flounder, and mackerel. We can imagine the eagerness with which he would have welcomed a marine laboratory for these and other researches in touch with his University and his class, as at fortunate St. Andrews. A skilful artist (for his touch on the black-board always delighted his students), he made a series of coloured drawings of the various stages in the developing cod, and sent them to the Great Fisheries Exhibition in London in 1883, where they attracted the attention of all marine zoologists, and stimulated those specially interested in the fisheries to further investigations. He was truly the pioneer in this department and was worthy of the distinction, though subsequent observations demonstrated that the ways of Nature in the ocean are not at the mercy of currents. Thus, for example, the young cod, hatched in the offshore, seek the rocky margins of the inshore when about an inch in length, whilst the haddock passes this stage in deep water. The herring, moreover, appears to be independent of drift and currents, its eggs being adherent to the bottom, producing larvæ and young which remain near their birthplace until their powers of swimming enable them to follow Nature's instincts. Currents, again, will not fully explain the life-history of the eel. Be this as it may, G. O. Sars has the honour of leading the way into this important field. In 1874 he was appointed to the chair of zoology in the University of Oslo as successor to Prof. Halvor Rasch.

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[1] I have thankfully to acknowledge information concerning the deceased naturalist from Dr. Nansen, Prof. Nordgaard, and Dr. Calman.

Sars' continuous researches in marine zoology during a long life are almost unequalled in the history of the subject, and strike the observer both with respect and amazement. Not only did he largely extend the boundaries of knowledge in relation to his own wonderful seas (not to allude to his work in editing various posthumous memoirs of his father), but also most of the important expeditions, from the *Challenger* to the "Voyages of the Prince of Monaco," sent him materials for study. Further, collections from New Zealand and Australia, China and the Polar Sea, South and Central Africa to Tanganyika and other places, furnished materials for his eager microscope, even dried mud from Australia and New Zealand disclosing new forms to the indefatigable worker. Moreover, when we reflect that whilst his special studies centred in the wide field of the Crustacea with autograph figures of all the Norwegian species, his unceasing labours comprehended Protozoa, Cœlenterates, Echinoderms, Bryozoa, Annelids, Mollusca (including a volume of 446 pages and 52 autograph plates on those of Norway), and even added to our knowledge of the Blue Whale and the Finner, our admiration is involuntary. No self-seeking element was there, only the inborn and genuine love of Nature and her works. His numerous original memoirs were mostly illustrated by his own facile pencil and brush, and when it is mentioned that no less than two thousand two hundred and thirty plates—including a few maps—were a portion of the result of his untiring zeal, some idea of the stupendous task may be estimated, a task at which even a more robust frame may have quailed. His studies on the copepods alone were sufficient for a reputation.

Sars' strenuous life made him more or less a recluse, but he was beloved by his students and friends, and he was ever ready to help a scientific visitor from other countries with his great knowledge and experience. As a foil to his labours he was wont to solace himself with his violin, as befitted a member of a musical family. Of a wiry frame and with refined features and dark hair like his mother and his late charming and accomplished sister, Mrs. Fridtjof Nansen, he was enabled to carry on his researches until a week or two before his somewhat sudden death—from weakness and old age. He passed away just as his colleagues, friends, and pupils had thought to celebrate the old scientist's birthday, and they had to be content with assembling at the grave to pay a last tribute. Yet though his hair whitened and his sight became dim, whilst the cramp of age somewhat affected his writing, his drawings to the last lost little of their pristine firmness and beauty—so much valued in his early years by his father. His long and busy life of unswerving devotion to marine zoology was as noble as it was rare. His career throughout was an honour to science, to his country, and to his race, and though Norway has a roll of many distinguished zoologists and explorers, it will be long before so enthusiastic and so persevering a student of the rich creeks, bays, and seas of his native country will be found.

Sars was an honorary member of numerous scientific societies in Europe, the United States, and New Zealand. He was also Commander of the 1st Order of St. Olav of Sweden; indeed, he was the recipient of many honours appreciative of his distinguished services to science. W. C. M.

PROF. M. F. FITZGERALD.

PROF. MAURICE FREDERICK FITZGERALD, B.A. (Dublin), D.Sc. (Belfast), was born on July 10, 1850, and died on May 4. The eldest son of the late Right Rev. Wm. FitzGerald, Bishop of Killaloe, he came of a family greatly distinguished in science. A brother of the late Prof. George Frances FitzGerald, F.R.S., and nephew on the mother's side of the late George Johnston Stoney, F.R.S., and Bindon B. Stoney, F.R.S., the eminent engineer, he early showed mental powers of a high order. He entered Trinity College, Dublin, in 1867, gained a scholarship in mathematics, and graduated with honours in 1871. In the following year he became a pupil with Messrs. Easton and Anderson of Erith ironworks. Under that firm he had experience on the sewerage of Doncaster and the erection of pumping machinery on the Clyde, and in 1875 went to Russia to instal similar plant at the Cronstadt graving docks. He was afterwards employed by the Russian Government on works at Riga and Odessa, and on his return to Ireland took part in important drainage works on the Shannon.

In 1884 FitzGerald was appointed to the chair of engineering in Queen's College, Belfast, a post which he filled with conspicuous success for twenty-six years. He endeared himself to a long succession of students by his most lovable character and striking individuality as a thinker and teacher. His pleasant voice with its slight touch of southern brogue, his keen sense of humour, and his zest in handling mathematical problems, gave his teaching a constant charm, increasing as the course advanced. The gentle, happy manner in which he put at their service his great natural and acquired abilities made an unforgettable impression on those who knew him as a teacher and a friend. No pains were too much for him in training men for the arduous career of an engineer, and his guidance and help were freely extended to them after they had graduated. Poverty in material equipment was the lot of all engineering schools until recent times, but FitzGerald had the gift of making improvised models serve the purposes for which expensive apparatus is now widely available.

Before his retirement in 1910, largely due to the stress and strain of his constant but always unobtrusive work in Belfast, FitzGerald had the joy of framing the main lines of a modern engineering school with laboratories in the reconstituted Queen's University. His services were always freely given for the furtherance of the best interests of Belfast and its University. He co-operated heartily with the civic authorities in the foundation and development of their great technical institute, which is most happily linked with the University, and his advice was much appreciated. He took, as Fleeming Jenkin did, an active and potent interest in the improvement of the status and methods of craftsmen employed in plumbing and drainage. This was work of a kind dear to his heart, as he loved the workman, and longed to bring all good knowledge to his aid. He was an indefatigable worker, and filled in any free periods by the pursuit and criticism of questions of the higher mathematics and the subtle riddles of philosophy. He was, moreover, an excellent classical scholar.

His brother George and he had very acute and analytical minds and foreshadowed, if they did not reveal, some of the important discoveries and now accepted theories which have made later students famous. Withal FitzGerald was one of the most modest and unselfish of men, caring not at all for credit so long as good results were secured. His main work was that of a teacher, but some papers by him on rotating discs, whirling shafts, and other abstruse subjects were published in the proceedings of scientific societies. He prepared, after barometric observations over long trails on the Mourne Mountains, an interesting map of their contours.

In 1893 he married Annie Maria Charnock. Their only child, William, joined the Royal Flying Corps early in the War and was killed on service in France. To know Maurice FitzGerald was to gain an added faith in humanity.

News and Views.

THE Colonial Office Conference at its meeting on May 27 adopted the Report of Committee A on Colonial Scientific and Research Services. The committee restricted its inquiry to the three major groups of applied science affecting the non-self-governing Dependencies—namely, medicine, agriculture with its auxiliary branches, and veterinary science and forestry. Since, however, in most of these territories agriculture, including stock-raising, is the principal occupation of the populations, the committee has dealt chiefly in its report with the organisation of the agricultural services. It recommends the constitution of a central council with a chairman appointed by the Secretary of State for the Colonies (who should be a layman), a director (who should be a scientific worker of standing), and a deputy-director (with Colonial administrative experience). The functions of the council should be to make recommendations to the Secretary of State in regard to the broad lines of research programmes, the establishment and maintenance of a chain of Imperial research stations, the creation of a clearing-house of information, the organisation of a pool of scientific workers, and the organisation and general principles of administration of a Colonial Agricultural Research Service. Liaison is to be established and maintained with the Empire Marketing Board, the Medical Research Council, and any other body already existing or set up for the prosecution and encouragement of research of importance to the Dependencies. Although the committee recommends the immediate establishment of distinct services for medical, agricultural, and forestry research, and so on, the possibility of their eventual fusion into one common research service is not discounted. In the formation of the Colonial Agricultural Research Service the committee states that the following condition should be fulfilled: it must be well paid, the members of the service should be liable to transfer, but an officer entering the service must be safeguarded against any loss on transfer.

THE annual report for 1926 of the Imperial Institute shows the progress that has been made since the passing of the Imperial Institute Act of 1925, under the administration of the new Director, Lieut.-General Sir William Furse. The Institute is divided into two departments, dealing respectively with plant and animal products, and with mineral resources. The former, which has seven committees and is under the chairmanship of Sir David Prain, appears the more active; it has during the past year answered 920 inquiries on subjects, of which a selection are mentioned in the report; they include the prevention by planting of the migration of sand dunes in Somaliland, the utilisation of locusts for the manufacture of oil, the machinery for oil palm, and inquiries as to many vegetable products. The Mineral Resources Department during the year has answered 430 inquiries, and has a list of 16 committees. The most active development during the year has been the rearrangement of the exhibition galleries on modern museum lines, aided by contributions from seventeen out of the forty-four British Dominions and Colonies. The reserve material is being removed to store and sample rooms, where it will be readily available for examination by experts. The galleries are being devoted to exhibits of popular interest with many attractive dioramas and transparencies. An Empire Art Gallery offers to exhibit gratuitously the works of artists from any part of the British Empire. The plan is to make the galleries 'a permanent Wembley' to arouse interest in the Empire and serve as demonstration galleries in connexion with the teaching of geography in London schools. The educational work is being aided by the grant of £6000 from the Empire Marketing Board for the equipment of a cinema, and £1000 a year for five years for its maintenance.

THE financial statement for the year shows that the Imperial Institute has an income of £43,600, of which £33,500 is required for the expenses of the staff, and £1245 for publications. The popular exhibition of material and the development of the Institute to supplement the geographical classes in London schools will not by themselves fulfil the purpose of the Institute and are not likely to secure the permanent financial support of the Dominions and Colonies. They at present contribute £21,000 a year. The statement, however, that the Mineral Resources Department is to publish reports on its investigations shows that the Institute is preparing to improve its service as an information bureau for the Empire by undertaking further investigations on the natural products of our overseas Dominions and Colonies. The permanent success of the Institute will largely depend upon this side of its work. It is discouraging to hear that, in spite of the vast size of the Imperial Institute buildings, the lack of storage space renders necessary the sacrifice of specimens, and that, as regards the Library, "unless further accommodation is provided, much valuable reference material may have to be destroyed, which would considerably affect the efficiency of the two technical departments."

THE annual meeting of the British Science Guild was held on May 26, Lord Askwith occupying the chair. The report presented by Sir Richard Gregory, chairman of the Executive Committee, described the varied work of the Guild, special reference being made to the Supplement, published during the year, to the Catalogue of British Scientific and Technical Works. The Supplement was compiled by Miss D. Shaw from the lists published monthly in NATURE, and its publication was aided by the Carnegie United Kingdom Trust. Sir Richard Gregory admitted the disadvantages of keeping the Catalogue up-to-date by means of annual supplements, and stated that no more supplements would be published, though the issue of a new volume might be undertaken by the Guild later. The report included the text of a leaflet prepared by the Guild's Health Committee on the important question of the medical certification of the fact of death and on the signs of death, in which three simple tests of the fact of death are described. The Guild has been fortunate in securing Sir Alfred Mond as its president in succession to Lord Askwith, whose term of office has expired. Sir Alfred Mond possesses an unusual combination of qualifications for his new work. His name is known and honoured in science, politics, and industry, and his recent achievement in forming the great chemical combine known as Imperial Chemical Industries, Ltd., must contribute, directly and indirectly, to the advancement of pure and applied scientific research. But perhaps his most valuable qualification is possession of the "Yes" complex, to use his own expression, a qualification valuable in any president of a society, but especially in one with such an ambitious programme of work as the British Science Guild.

THE twelfth lecture of the series "Physics in Industry," arranged by the Institute of Physics, was given on May 25 in the rooms of the Institution of Civil Engineers, by Prof. W. E. S. Turner, professor of glass technology in the University of Sheffield. The subject was "Physics in the Glass Industry." Prof. Turner said that although individual scientific workers, among them Faraday, investigated the properties of glass, the subject received little attention in scientific institutions until very recent years. He referred to the research initiated in industrial laboratories on the processes of glass-making and on the properties of the material, and to the impetus which the War gave to these investigations, particularly on optical glass. Manufacturers have believed, and the belief is difficult to eradicate, that correct annealing depends on 'baking' the glass; but recent research on the variation of viscosity with temperature, and in particular the relationship deduced by Twyman, as well as the further investigations which followed from his observations, have shown that the rate of cooling is the important factor. These observations, and related research at the National Physical Laboratory, the University of Sheffield, and elsewhere have resulted in highly important improvements in annealing practice and economy of time in manufacture. Three of the principal physical properties of glass are providing fruitful fields of research, namely, thermal expansion, electrical conductivity, and optical properties. For example, expansion measurements as carried out at the Research Laboratories of the General Electric Company have led to improvements in the manufacture of electric lamps; while observations of the absorptive properties of glass for radiation in different parts of the spectrum have led to the introduction of special glasses for therapeutic and other purposes, for example the 'vitaglass' of Messrs. Chance Brothers.

DISCOVERIES of considerable archæological and historical importance have been made by M. F. Bisson de la Roque on behalf of the Louvre, while working under M. Georges Foucart, Director of the French Institute of Oriental Archæology, at the Temple of Madamud near Luxor. In 1925, a temple of the Twelfth Dynasty was found underneath the Græco-Roman temple, which lies a metre below the present surface, and statues of Senosrit III. and Senosrit II., as well as inscriptions, revealed the existence here of an important sanctuary of the Middle Empire. In 1926, four groups of statuary were discovered, figuring the local god of war, Montou, and his consort Ra Tooui, the first statues ever discovered of these deities, whose cult, lasting down to Græco-Roman times, evidently rivalled that of Ammon

Ra himself. A remarkable bas-relief figures a Roman family partaking of the annual ritual feast held at night. The operations of the current season, which are described by the Cairo correspondent of the *Times* in the issue of May 24, have been directed towards clearing the sacred enclosure around the Temple and its annexes, and have demonstrated the limits of the sacred lake.

The sensational find of the past season's work, however, came from the Ptolemaic temple itself, where excavations of the interior have brought to light, from the relatively small areas as yet explored, a mass of stone fragments—panels, statues, pillars—used by the builders of the temple for their foundations. On these fragments, which were derived from older buildings formerly standing on the site, are inscriptions and sculptures of the Twelfth Dynasty and, of more importance, of the Thirteenth Dynasty, the first dynasty of the period between the Twelfth and Seventeenth Dynasties of which both historically and culturally practically nothing is known. Seven kings have left at Madamud evidence of their architectural activity, one of them a king hitherto unknown. It is said that the art of the Thirteenth Dynasty here revealed is very characteristic and quite distinct from that of the Twelfth Dynasty, though showing the same qualities of sobriety and elegance. The evidence to be obtained from this discovery, both now and after further exploration, will undoubtedly carry great weight in the discussion of Egyptian chronology and the length of the period which intervened between the Twelfth and Seventeenth Dynasties.

Among the greatest of recent earthquakes, whether measured by disturbed area or the range of its recorded oscillations, is that of Dec. 16, 1920, in the province of Kansu in north-west China. Yet even this great shock seems to have been exceeded in violence by that which occurred on the evening of May 22. According to a letter from Prof. Turner (*Times*, May 25), the first tremors reached Oxford at 10.32 P.M. (G.M.T.). From the records there and at four other observatories (Kew, Helwan, Hyderabad, and Perth in West Australia), he places the epicentre in lat. 35·8° N., long. 103·4° E., or near the western margin of the province of Kansu. That of the earthquake of Dec. 16, 1920, lay in lat. 35·8° N., long. 105·7° E. Eight days later, a strong after-shock occurred about 90 miles to the west, in lat. 35·5° N., long. 104·0° E. Earthquakes of the first magnitude are rarely repeated within the same origin except at very long intervals, say, a century or more, and it is interesting to notice the continued westerly migration of the focus, the distance between the origins of the great earthquakes of 1920 and 1927 being about 130 miles.

Many readers of Nature will regret to learn that Mr. John Jones, the Registrar of the Imperial College of Science and Technology (which includes the City and Guilds College), retires at the end of the current session. Mr. Jones became a member of the staff of the City and Guilds College when it was opened in 1884—it was then known as the Central Institution—and he has ever since been engaged in its administrative work. His influence on the students has been far reaching. He has taken a personal interest in their welfare; in fact, it is not too much to say that he has devoted the greater part of his life to this purpose, and not only has he followed closely the progress of each one of them in the College, but also, as secretary of the Appointments Board, he has helped many of them in their subsequent careers. His knowledge of the hundreds of students who have passed through the College is remarkable, and he has often astonished men who left many years ago by recalling forgotten incidents of their youth. He leaves the Imperial College with the good wishes of every one, and a deep appreciation of his work, ability, and personality will long remain in the minds of all who have been associated with him there.

Recent acquisitions to the British Museum (Natural History) include the following: The Department of Zoology has acquired a large and very rare squid (*Stenotheuthis caroli*) which was washed ashore in March last at Scarborough. This is especially interesting, since the stranding of large Atlantic squids on the British coasts is relatively uncommon. Messrs. Lever Bros. have presented to the same Department a complete skull with baleen plates of a Blue Whale from one of their Scottish whaling stations. The specimen from which this skull was taken was a male 72 ft. long, and the skull itself measures 17 ft. 6 in. long by 9 ft. 3 in. wide. Among purchases for the Geological Department, the most important is a beautifully preserved skeleton of an ichthyosaur, nearly 13 ft. long, on a slab of Lias shale from Holzmaden, Württemberg. This is believed to represent a new species of the genus Eurhinosaurus, of which only one other example is known—the *E. longirostris* of the Stuttgart Museum. A band of rock in the Devonian of Gerolstein in the Eifel is famous for its crinoids (sea-lilies), but specimens with the stem attached are very rare; a slab bearing four stalked specimens of Hexacrinus with arms complete is therefore an unusual acquisition. The Department of Minerals has acquired a magnificent crystal of beryl (aquamarine) of gem quality, 13 cm. high, with a diameter of 10 cm. to 12 cm. and weighing 2505 grams (12,525 carats), from Brazil. This gem is exceptional in size and in the perfection of its crystalline development. Important financial assistance has been given by Mr. J. Spedan Lewis to a collecting expedition in Indo-China under M. Delacour and Mr. Willoughby P. Lowe. The results of this expedition are to be divided between the British Museum (Natural History) and the Paris Museum.

China has been much in the public eye during the last few months: the notoriety achieved would suggest that the atmosphere is not very suitable for scientific work, so that we may congratulate those who have succeeded in producing a new scientific journal and extend a welcome to the first number of the first volume of the *Chinese Journal of Physiology* published in January last. It is to be issued quarterly by the

Chinese Physiological Society, and is edited by R. K. S. Lim, B. E. Read and Hsien Wu of Peking; and H. G. Earle of Hongkong. A number of papers deal with Chinese drugs and their pharmacology, including Chinese aconite, bastard anise, and ephedrine. R. K. S. Lim describes a method of anastomosing blood-vessels by means of aluminium couplers, and with C. T. Loo and A. C. Liu has used the method in transplanting the stomach or a gastric pouch in the dog. By showing that the transplant secretes to a meal they have demonstrated the existence of a humoral, as distinct from a nervous, mechanism of gastric secretion, thus confirming the results of Ivy and Farrell. H. Necheles describes a new method of vividiffusion, using tubes made of goldbeater's skin as dialysers: the method has been applied to show the presence of a gastric secretory stimulant in the circulating blood. All the articles in this number are in English, but articles in French or German will also be published: each paper is accompanied by an abstract in Chinese.

The firm of Messrs. Ernest Benn, Ltd., has recently begun the issue of a series of booklets which "has the revolutionary aim of providing a reference library to the best modern thought, written by the foremost authorities, at the price of sixpence a volume." Of the titles which have so far been announced, one half relate to scientific subjects, namely, "Modern Scientific Ideas," by Sir Oliver Lodge; "The Age of the Earth," by Prof. Arthur Holmes; "The Atom," by Prof. E. N. da C. Andrade; "Chemistry," by Dr. P. E. Spielmann; "Relativity," by Prof. James Rice; "The Mind and its Workings," by Mr. C. E. M. Joad; "Psycho-Analysis," by Dr. Ernest Jones; and "Introduction to Economics," by Mr. L. C. Robbins. The first three of these have already appeared, and if they are representative of the series as a whole, Messrs. Benn are to be complimented on the provision of a very valuable addition to scientific literature of the popular kind. The subjects are treated in an interesting and easily comprehensible manner, and the scope of about 30,000 words is sufficient to give the reader a good general idea of the present state of knowledge and belief in the various departments of science. Sir Oliver Lodge's contribution is described as "the expanded substance of six talks on 'Atoms and Worlds,' broadcast in October and November 1926." It therefore necessarily covers in the main the same ground as Prof. Andrade's book, and it is of considerable interest to note the varying manner of treatment of the same material by two decidedly individualistic writers.

A free public lecture on "The Eclipse of the Sun" is to be given at the East London College on Tuesday, June 14, at 5 o'clock, by Sir Frank Dyson, Astronomer Royal.

The University of California has conferred the degree of doctor of laws upon Prof. H. H. Turner, Savilian professor of astronomy in the University of Oxford.

At the annual general meeting of the Linnean Society of New South Wales, Prof. L. Harrison, Challis professor of zoology in the University of Sydney, was elected president for the present session.

Mr. H. J. Page has resigned his position as chief chemist and head of the Chemical Department at the Rothamsted Experimental Station on his appointment as head of the Research Laboratories of Nitram, Ltd.

At the tenth annual general meeting of the Society of Glass Technology, held in Sheffield on Wednesday, April 27, Mr. W. Butterworth was re-elected president and the following officers were elected to fill vacancies: *Ordinary Members of Council*, Mr. J. D. Cauwood, Mr. F. Graves Clark, Miss V. Dimbleby, Mr. G. V. Evers, and Mr. W. W. Warren. *Honorary Secretary*, Prof. W. E. S. Turner.

In connexion with the meeting at Essen on June 7–19 of the Association of German Chemists (Verein Deutscher Chemiker) "Achema" (Ausstellung für chemisches Apparate-Wesen) is arranging an exhibition of chemical apparatus and appliances. The exhibition will be held in the exhibition ground in the Norbertstrasse at Essen. The offices of the "Achema" are at Seelze, Hannover, to which all communications should be addressed.

Donations amounting to £250 were received by the Committee formed to found a memorial to the late Mr. F. S. Spiers, secretary of the Faraday Society and the Institute of Physics. The interest on this fund is to be available for the payment of an honorarium to a lecturer on some subject in physical chemistry, the lecture to be given once in three years and to be called the Spiers Lecture. The Faraday Society has undertaken the administration of the fund for this purpose.

The twenty-eighth annual meeting of the American Roentgen Ray Society will be held in Montreal on Sept. 20–23, under the presidency of Dr. A. Howard Pirie, of Montreal. This is the first occasion on which the Society has met outside the United States; and, to acknowledge the honour paid to a British radiologist by his election to the presidency of the Society, a party of radiologists from Great Britain is proceeding to Montreal in September to take part in the proceedings. Dr. G. W. C. Kaye has been invited by the Society to give the Caldwell lecture.

Some details of an exploring expedition now at work in New Guinea are contained in the *Geographical Journal* for May. The expedition, which is under government auspices, is led by Mr. C. H. Karius, and left Port Moresby for the Fly River some four months ago. The Fly was to be ascended to Lario Bank by boat, where the party were to cross overland, east of the swamps, through unexplored country to the head waters of the Fly at Palmer River and the Sepik River. Thence Mr. Karius hopes to strike across the Victor Emmanuel Range and reach the Sepik lower down and follow it to Marienburg near the mouth.

The history of science quarterly, *Archivio di Storia della Scienza*, directed by Prof. Aldo Mieli, and published at Rome by the Casa Editrice Leonardo da

Vinci (Roma, 40; Via Casalmonferrato, 29), has hitherto contained articles mainly by Italian scholars. In order to render its character more international and to widen its sphere of influence, honorary editorial representatives of other nationalities have been appointed to further the cause of the journal in their respective countries. The editor for England is Mr. E. J. Holmyard (Clifton College, Bristol), who will be pleased to receive articles for publication in the *Archivio* and also to supply any information as to rates of subscription, etc. Books for review in the *Archivio* may be sent to him, or direct to Prof. Mieli, c/o the publishers, at the above address.

An appreciation of William Bateson by an anonymous writer (*Jour. of Heredity*, vol. 17, No. 12) gives a short account of his life and work, showing that by his death the whole scientific world suffered an irreparable loss. A photograph of Merton House, Grantchester, where he lived eleven years, is given, as well as Rupert Brooke's exquisite poem on the old vicarage. It was here that the phenomenon of coupling and repulsion was discovered in sweet peas; here also that the inheritance of the various types of combs in fowls was investigated; and that "Mendel's Principles of Heredity" was written. As the exponent of discontinuity in biology and the founder of genetics, Bateson's place is secure in the history of biology, while his personal qualities will long be an inspiration to those who knew him. The article concludes with a list of his chief published papers.

A reviewer in Nature of May 21, p. 739, referred appreciatively to Bragg's crystal structure discoveries, and mentioned Sir William Bragg's name alone. The reference should, however, have been to both son and father, for both were jointly concerned with the notable work on crystal structure. Indeed, Sir William Bragg says in the preface of the joint book on "X-rays and Crystal Structure" by Prof. W. L. Bragg and himself, published in 1915: "I am anxious to make one point clear, viz. that my son is responsible for the 'reflection' idea which has made it possible to advance, as well as for much the greater portion of the work of unravelling crystal structure to which the advance has led."

A booklet entitled "The Production and Distribution of Clean Milk" has been prepared by Mr. A. T. R. Mattick (*The Dairyman, Ltd.*, 43 Great Tower St., E.C. 2*s.* net), dealing with the essential factors for the production of clean milk. It is profusely illustrated and gives much useful information. Clean milk is of importance not only to the consumer but also to the producer, for clean milk is milk with improved keeping qualities, and much monetary loss (estimated at £425,000 per annum) falls upon the producers in Great Britain owing to souring before delivery.

"Why Everybody should assist in fighting Disease in the Tropics" is the title of a pamphlet issued by the Ladies' Committee of the Ross Institute and Hospital for Tropical Diseases, Putney Heath, appealing to members of the public to become associates of the Institute (minimum annual subscription, 10*s.* 6*d.*). It is hoped in this manner to obtain the funds necessary for maintenance purposes, so that other donations may be placed to the endowment fund. Mr. John Masefield contributes a forceful foreword on the value of research in tropical diseases and of Sir Ronald Ross's contributions to the subject.

Under the title "Modern Fruit Tree Spraying and what it Costs," the Ministry of Agriculture has recently issued an illustrated brochure, by Mr. J. Turnbull, useful to fruit-growers. It is issued as Miscellaneous Publications, No. 58, and is obtainable at the office of the Ministry, 10 Whitehall Place, London, S.W.1, price 6*d.* post free. The pamphlet is written to meet the difficulties that growers often encounter in their spraying operations and are nearly always due to inattention to some detail the importance of which is frequently not realised. The grower can be confidently recommended to consult this publication for information respecting the type of spraying plant best adapted to his needs and the relative costs of operation in each case.

Messrs. G. Cussons, Ltd., of the Technical Works, Manchester, have sent us a copy of their folder of illustrations showing types of apparatus and equipment suitable for use in technical schools and colleges. The excellence of Messrs. Cussons' models is widely appreciated, and in this pamphlet will be found particulars of apparatus for teaching dynamics, building construction, hydraulics, steam, electricity and solid geometry. Among, perhaps, the most interesting of the appliances illustrated are the model for explaining the winding of armatures, the experimental air channel and fan-testing apparatus, and a complete hydraulic plant, including an electrically driven centrifugal pump, reservoir, Pelton wheel, Thomson turbine, weir tank, sump and Pitot tube. Many of the pieces of apparatus are designed especially for laboratories where wall space is limited or where portable apparatus is desirable.

Messrs. Gallenkamp's catalogue of general and industrial apparatus (19 Sun Street, Finsbury Square, E.C.2) has been very greatly expanded to meet the multifarious demands of scientific workers not only in pure chemistry but also in the cognate sciences and in various branches of technology. Thus, in the eighth edition, in addition to the ordinary equipment of furniture and apparatus used in educational laboratories, ample provision is made for the consultant and for the research worker in every department of chemistry, and also for the study of such special kinds of work as the testing of coal, cement, asphalt, petroleum, soils, milk, sugar, beer, wines, spirits, vinegar, and textiles. Mechanical apparatus offered for sale includes petrol-gas generators, high vacuum pumps, and centrifugal machines of various types, and amongst the electrical equipment we find drying-ovens, furnaces, motors, and commutating rectifiers. There is also a wide choice of optical apparatus such as microscopes, spectrometers, quartz spectrographs, polarimeters, refractometers, projection lanterns, and epidiascopes, whilst the botanist will find a lengthy list of fresh and preserved material, together with microtomes and other essential apparatus. A valuable feature of the book is the inclusion of a mass of useful information interspersed at intervals, much of the apparatus being not only clearly depicted but somewhat minutely described. Thus there is a general description of the electrometric apparatus used for determining hydrogen-ion concentrations, together with details for its use and for the preparation of the electrodes. Similarly, anemometers for measuring the speed of draughts in flues, viscometers, electric furnaces, pyrometers, and also the automatic recording balance for studying the sedimentation and flocculation of soils, are well described. At the end there is a long list of text-books and works of reference, classified according to subjects, and 46 pages are devoted to chemicals and reagents—products of the British Drug Houses, Ltd. The volume is attractively bound and well illustrated.

Applications are invited for the following appointments, on or before the dates mentioned:—An assistant in the medical unit of the Welsh National School of Medicine—The Secretary, University College, Cardiff (June 15). A lecturer in painters' oils, colours, and varnishes at the L.C.C. Hackney Institute, Dalston Lane, E.8—The Education Officer (T.1.a.), The County Hall, Westminster Bridge, S.E.1 (June 15). A Government Inspector of Mines, Tanganyika Territory—The Private Secretary (Appointments), Colonial Office, 38 Old Queen Street, S.W.1 (June 18). An assistant lecturer in physics in the University of Sheffield—The Registrar, University, Sheffield (June 18). Junior assistants in the electricity and engineering departments of the National Physical Laboratory—The Director, National Physical Laboratory, Teddington (June 18). Visiting instructors at the L.C.C. School of Engineering and Navigation, Poplar, for the following subjects: carpentry and joinery, acetylene welding, electrical installation work, engineering workshop practice, and engineering economics—The Education Officer (T.1.a.), The County Hall, Westminster Bridge, S.E.1 (June 20). A demonstrator of physics at St. Bartholomew's Medical College—The Dean of the College, E.C.1 (June 23). A junior technical officer for the Air Ministry Technical Development Staff, to assist in development work in connexion with aeronautical instruments and small precision apparatus, with special reference to problems relating to high altitude flying—The Chief Superintendent, R.A.E., South Farnborough, Hants (June 25, quoting A.158). A head of the textile department of the Harris Institute, Preston—The Principal and Secretary, Harris Institute, Preston (June 30). A demonstrator in the department of mechanical engineering and motive power of the City and Guilds (Engineering) College—Prof. W. E. Dalby, City and Guilds (Engineering) College, Exhibition Road, S.W.7.

Our Astronomical Column.

Exploded Wires.—The reports of the great American observatories in recent years make frequent mention of observations on 'exploded wires.' Those who wish for information on the nature and object of these experiments will welcome an article on the subject by Prof. H. N. Russell in the *Scientific American* for May. The wires are made of various metals or alloys and drawn out to extreme thinness. A powerful current from a condenser charged up to about 40,000 volts is then passed through them, instantly reducing them to gas. The spectra of this gas at its various stages of cooling are then photographed with the aid of a rapidly revolving mirror, the whole phenomenon lasting about 1/25,000 of a second.

From the initial brightness it is estimated that temperatures of 20,000° C. are attained. The vapour at this time is far hotter and brighter than the solar photosphere, and approximates closely to the photospheres of the hottest stars. It has been proved that when hottest and least expanded, the column of glowing gas is opaque, and gives a continuous spectrum. It is at that time a good conductor of electricity, which is given as an explanation of its opacity. A bright-line spectrum from an electric spark shows up when placed in front of the exploded wire, but is invisible behind it. On the other hand, as the gas of the exploded wire cools, the continuous spectrum weakens and disappears, and the bright lines due to the incandescent gas appear.

The two stages correspond to the spectra of the solar photosphere (hot and opaque) and of the reversing layer (cooler and transparent). It is possible to get both spectra at once by placing the wire to be exploded inside a wooden groove, thus retarding the expansion of the gas. The cooler gas in the outer part of the groove acts as the transparent reversing layer; the hotter gas within acts as the photosphere, and the familiar Fraunhofer lines are seen.

The changes in the spectrum of the exploded wire are similar to those in a nova, and show that the phenomena exhibited by the latter are due to the rapid expansion of the gases at its surface owing to abnormal heating from some unknown cause. These experiments have probably produced the highest temperatures and the closest approach to photospheric conditions that have yet been attained on earth.

The Position of the Axis of Mars.—There are now three determinations of the position of this axis that have some claim to precision: (1) Lowell, from the polar cap; (2) W. H. Pickering, from other markings on the disc; (3) Struve, from the satellites. The question has been brought before the superintendent of the American Ephemeris, Prof. W. S. Eichelberger, as the computations for physical observations of the planets are made in that office. He has taken the opinion of several astronomers and has himself revised Struve's work of 1911, using observations up to 1924. His revision indicates that Struve's position accords well with recent observations, and further, he notes that a recent revision by Prof. W. H. Pickering gives a result much nearer Struve's position than his published result. On these grounds he has decided to use Struve's position in the American Ephemeris (and the other almanacs that use its data), beginning with the year 1931.

Research Items.

GYPSY LINGUISTICS.—In vol. 5, No. 4, of the *Journal of the Gypsy Lore Society*, Prof. R. L. Turner, by his ingenious application of methods of analysis to ascertain the position of Romani in Indo-Aryan, is able to offer suggestions as to the probable date, place, and line of departure of the gypsy exodus from India. An initial criticism disposes of the theories which assign Romani an affinity with the Dard group and that of its opponents who connect it with languages now farther in India, such as Western Pahari. The failure of both schools is due, according to Prof. Turner, first to comparison of Romani with a dialect group as it exists to-day, and secondly to neglect of the differences of value in the principles of conservation and innovation as evidence for determining dialectal connexions. Taking the early isoglosses in primitive Aryan, the middle Indo-Aryan of the Asokan edicts, Pali and the literary Prakrits, and the modern languages, the argument from the innovations points to an agreement between Romani and the central group and a difference from the north-west. Romani therefore belonged originally to the central group which now comprises Rajasthani Hindi, central and eastern Pahari, and perhaps Behari. Turning to conservations, Romani has preserved sounds which were radically modified in the central group after the gypsies had passed to the north-west, possibly about 250 A.D. Later innovations which arose in the north-west during the stay of the gypsies with that group appear in Romani, as might be expected. The argument is further borne out by an examination of both vocabulary and morphology. It is, however, by no means certain that the gypsies entered Persia speaking a single language, as Dr. Sampson maintains. There are striking differences of morphology and vocabulary between European, Armenian, and Syrian Romani, while many of the resemblances might be referred back to a common Indian origin rather than a post-Indian period of community. Yet even if at the time they emerged from the Hindu Kush they were already separated by certain isoglosses, it is reasonable to suppose they preserved contact and exerted a certain amount of mutual linguistic influence.

GAS STORAGE OF FRUIT.—The Department of Scientific and Industrial Research, Food Investigation Section, has just published Special Report No. 30 (London: H.M. Stationery Office, 1927. 1*s*. 9*d*. net), on gas storage of fruit, the research in connexion with which has been carried on by Messrs. Franklin Kidd, Cyril West, and M. N. Kidd. Their investigation, though still in the pioneer stages, may have considerable commercial importance. They have explored methods of extending the storage life of living fruit and vegetables, and retarding their natural senescent changes. Live fruits and vegetables in storage continue their process of respiration, and it seems possible by controlling the supply of oxygen and carbon dioxide to regulate the speed of the living machine as it travels through its normal course of growth and senescence. The method used was to store apples in a gas-tight chamber, the composition of the atmosphere of which could be regulated and varied by means of flues, and then to note the speed of ripening and compare the condition of the fruit with that of material stored in the ordinary way. In general, the authors' results show that within certain limits the rate of ripening of fruit after gathering is directly related to the amount of oxygen, and inversely to the amount of carbon dioxide present in the atmosphere in which it is stored. At the ordinary temperatures which obtain onwards from September through winter and spring, it was found that atmospheres containing about 10 per cent. of carbon dioxide, with an equivalent reduction in the amount of oxygen to about half its normal value, were the most effective. At lower temperatures the effectiveness of the method decreases, just as it does at higher temperatures. At ordinary temperatures the storage life of apples may be approximately doubled in length. Experimental evidence is also given to show that reduced concentrations of oxygen and accumulations of carbon dioxide actually depress respiratory activity in the apple, and this depression is approximately proportional to the increase in length of the storage life of the fruit.

GREEN MANURING.—A booklet has been issued (London: Ernest Benn, Ltd., 1927) containing the papers contributed to the third Rothamsted Conference. These conferences are attended by persons of practical experience in the special subject under consideration from widely varying localities, and their views carry much weight. The third conference dealt with green manuring, a practice already important in the tropics, and to a less extent in other parts of the world, but in England less widely employed at present owing to severe economic and climatic limitations. The use of green manuring is to build up fertility and augment the water-holding capacity of the soil, or to maintain a rich soil in good condition. Its importance therefore to the farmer naturally varies according to the supply and cost of farmyard manure. The general view of the speakers indicates that under favourable conditions green manuring can be used in Great Britain with considerable benefit to the succeeding crop, but that the practical difficulties are often very great; *e.g.* risks of drought or disease in the succeeding crop may be incurred, and the establishment of the catch crop is not always easy. Mustard fallow followed by wheat is at present the most general type of green manuring practised in England, but red clover before potatoes, and lupins in the case of light land, may be useful. Finally, emphasis is laid on the necessity for a study of local conditions, as general methods cannot as yet be recommended with safety.

SPEY SALMON.—In a report on the salmon investigations on the River Spey in 1923 (*Fisheries, Scotland: Salmon Fish*, 1926, V. (November 1926)), Mr. W. J. M. Menzies gives the results of the examination of 1763 fish caught during the months of April, May, June, July and August, in the sweep nets worked in the lowest two miles of the river's course. The majority of the fish were divided between the 1+, 2, and 2+ age groups, though of the three the 2-winters fish were slightly the most numerous. The 3-winters fish were unfortunately poorly represented owing to the lack of samples at the beginning of the season. April was mainly the spring fish month, May was a transition period between spring and summer fish, and June and July were almost wholly summer fish months. The bulk of the grilse appeared in July, and the decline in the number of grilse is again illustrated, occurring as it does in most Scottish rivers. 4·1 per cent. of the whole catch were previously spawned fish, and of these 72 salmon, only 2 had spawned twice. 66 per cent. of the smolts migrated after 2 years of river life and 33 per cent. after 3 years. The correlation between parr length at first year and age at smolt migration is again noticeable, the smaller parr at the end of the first year becoming 3-year smolts and the larger parr becoming 2-year smolts. This correlation appears to e continued also in the sea life.. The zone of rapid rowth on the scales begins to appear at the end of pril, and growth increases in rapidity as the summer dvances. The curious checks in this summer rowth that have been previously noted appear gain, in the 1+ group in July and in the 2+ group early a month earlier.

GENETICS OF LEBISTES.—The little cyprinodont ish, *Lebistes reticulatus*, has now been used for ome years in genetical experiments and has conistently shown a type of inheritance from male to nale through the Y-chromosome. Crossing over is ound to occur regularly between the X- and Y-hromosomes in males and between X- and X-hromosomes in females. As the result of extensive xperiments, Winge (*Jour. Genetics*, vol. 18, No. 1) lescribes the inheritance of eighteen genes for colour narkings in the males, the females being normally lull grey throughout. He has obtained forms with resh colour patterns from the West Indies and elsevhere, and believes that a large number of such olour varieties exist. Each pattern involves the resence of certain red, yellow, or black spots, accomanied in some cases by changes in the shape of the audal fin. Nine of the patterns here described are ew, and two previous patterns are shown by crossing ver to be compound. Of the whole number, nine re located in the Y-chromosome and three in the X-chromosome. Five of these have shown crossing ver. A single gene, causing stripes on the body, is ot sex-linked but is located in an autosome. It nust be said that the patterns, which are carefully ecorded in coloured plates, sometimes show a range f variation which may be due to their compound haracter. Dr. Winge emphasises the view that since, n Lebistes, crossing over occurs freely between the Y- and the X-chromosomes, a single dominant factor or maleness must be present in the Y-chromosome, and this must also presumably cross over, thereby transforming the Y- into an X-chromosome, or vice versa. Certain sex intergrades are also described.

EMBRYOLOGICAL STUDIES AND TISSUE CULTURE.—The Year-Book of the Carnegie Institution of Washington for 1925–26 contains reports of work done in the Department of Embryology. Young human embryos in the stages with 2 to 16 pairs of somites have been carefully investigated and monographed by Drs. G. W. Bartelmez and H. M. Evans, and a description of a still earlier human ovum has been published with coloured photomicrographs. Among numerous investigations of the blood and nervous systems may be mentioned the observation by Mrs. M. R. Lewis and Dr. H. B. Andervont, through tissue culture, that the sarcomatous tumours of chickens are composed chiefly of hypertrophied white blood corpuscles. They suggest that an irritant substance produced in the blood plasma stimulates these cells to abnormal activity; and they were able to transfer the tumour from chicken to chicken through either the blood plasma or the white cells. Rat tumours were similarly found to consist of an epithelioid modification of the mononuclear blood-cell, such cells if transplanted producing a fresh tumour. Among anthropological studies may be mentioned measurements of the Rama and Sumu Indians in Nicaragua, the evolution of human teeth and the inheritance of webbed toes.

HYDROGRAPHIC SURVEYING.—In Publication No. 118 of the U.S. Coast and Geodetic Survey, Lieut.-Commander J. H. Hawley gives particulars of a wire sweep for use between two launches to locate obstructions to navigation such as isolated pinnacle rocks, wrecks, or coral formations. The sweep wire, up to 5000 yards in length, is weighted at either end and at intervals of 100 to 300 yd., and suspended from floats by lengths of wire, equal to the depth below the surface at which it is desired to search. Tow-lines from the launches are attached to the terminal weights, and sweeping is carried out at not more than 1½ knots. The sweep wire is made up in units of 100 feet attached to each other by a gadget which parts when the sweep wire meets an obstruction. The great length of the sweep wire and the fact that the method has been used successfully for the location of some 4000 obstructions over an area of 6000 square miles justifies the very complete details which are given of the equipment, and the methods used of plotting the swept channel. Particulars of the launches, their gear for shooting and getting in the sweep, and the method used for determining the actual depth of the sweep wire while being towed, are also included. Considerable skill must be required in handling in a moderate sea, while in rough weather any such method would be impracticable.

OCEAN CURRENTS.—The International Hydrographic Bureau at Monaco has published an article on "Ocean Currents in Relation to Oceanography, Marine Biology, Meteorology, and Hydrography" by Admiral Niblack (*Special Publication* No. 19). A study of oceanic currents by the Bureau had been suggested last autumn by a delegate from Peru, who "doubtless had in mind the sudden temporary and disastrous climatic change brought about in that country in 1923, when the Humbolt current, on the West Coast of South America, had deviated from its normal course," but the Bureau generally agreed that such a study should be left to the hydrographic departments of the maritime countries. In this popular review, Admiral Niblack discusses a number of lines along which further knowledge would be of practical value for purposes other than navigation. Answers to a number of questions upon the best available methods and instruments for attacking various outstanding problems are elicited from the readers of the review, in order "to assist in the standardisation of the methods and results of oceanographic exploration." It seems early in the life of this infant science of physical oceanography, bristling with problems which can only be attacked indirectly or must await advances in other sciences before their solution is possible, to seek standardisation of methods.

OIL PROSPECTS OF THE BATTLE RIVER AREA, ALBERTA.—The summary report of the Geological Survey of Canada for 1925, Part B, contains the results of much reconnaissance and detailed examination of the Battle River area, principally in the vicinity of the Alberta-Saskatchewan boundary. The stratigraphy is chiefly Upper Cretaceous, presenting a succession of alternately marine and nonmarine deposits. Generally speaking the structures are simple, the regional dip being gentle, though at least one broad fold, the Ribstone-Blackfoot anticline, has been proved; this fold has a N.E.-S.W. strike, with dips on either flank ranging from 7 ft. to 23 ft. per mile. It is doubtful whether such a flat fold in these Cretaceous deposits would be sufficient to cause oil or gas accumulation of any magnitude, and the question can only be decided by the drill. The author of the report, Mr. G. S. Hume, is not without optimism: while he admits that predictions are hazardous, he is of the opinion (based on certain assumptions) that the fold "may offer favourable prospects for oil." Much of his optimism seems to turn on a practical application of Munn's hydraulic theory of oil migration and accumulation. This theory, elaborated by J. L. Rich, defines the principal cause of oil and gas migration as "the movement of underground water which carried with it minute globules of oil and bubbles of gas, possibly as fast as they are formed. Accumulation results from the selective segregation of oil and gas, which on account of their buoyancy always tended to work their way upward as they are carried along and are caught and retained in anticlinal or other suitable traps." The author applies this theory to structural conditions in Alberta, pointing out that water might enter the porous Cretaceous beds of the foothills and travel eastward through the Alberta syncline, thus flushing the oil and gas eastward; this would have the effect of rendering the territory under survey at least potentially encouraging.

THE PRESERVATION OF STONE.—The first report which has been issued by the Department of Scientific and Industrial Research in connexion with the problem of stone decay makes very interesting reading (Report of the Stone Preservation Committee. Pp. iv + 33 + 4 plates. (London: H.M. Stationery Office, 1927.) 1*s.* 3*d.* net). It is of course very largely of a preliminary character, as, for example, in the part dealing with bacteriological attack, and wisely no attempt is made as to definite conclusions in dealing with so complex a problem, but Mr. Scott Russell is to be congratulated on the ingenious methods which he has developed for the study of the subject. The difficulty of preparing microscopic sections of a sound and hard piece of stone is well known, and while it is obvious that a microscopic examination of decaying surfaces is of the first importance, it is very difficult to see how this can be managed. Mr. Scott Russell, by his method of infiltration with a synthetic resin in the liquid form and converting it afterwards into the solid form, has solved this problem, and some of his photo-micrographs showing the presence of the deadly sulphate of lime crystals within the stone are of the greatest interest. He has also devised an ingenious method of determining the amount of, and kind of, porosity by impregnating the limestone with resin and then dissolving away the stone and examining microscopically the resin skeleton. Of special interest are his discussions of the weathering in London of Portland stone and the conditions existing where a soot layer has been formed. Up to a certain point the soot layer seems to have a certain preservative value, but in other cases bad rotting and decay is found behind the soot layer, and it is difficult to say to what causes these very opposite results of the formation of the layer are due. Investigations on the lines of those being pursued by Mr. Scott Russell will help us to solve very important and practical problems of this kind.

THE MECHANISM OF CYCLONES.—The issue of the *Proceedings of the Imperial Academy of Japan* for February contains an abstract of a paper by Mr. T. Kobayasi, of the Aeronautical Research Institute of the University of Tokyo, which describes an alternative theory of the constitution of cyclones to the 'polar front' theory of Bjerknes, and is to appear in full in the Report of the Institute. According to Kobayasi, the 'squall line' in a cyclone is the line along which the air that has entered the cyclone from the districts north-east of its centre comes into contact with that coming from the south-east. If there is a temperature gradient in the north-south direction, the two streams produce a discontinuity of temperature along this line. The theoretical shape of the line agrees with the actual shape of the squall line on the weather map in many cases. In the upper atmosphere the cyclone is taken as a vortex in a stream, and lines of flow and pressure distribution curves are shown. The heights at which this is a plausible description of a cyclone are calculated from the speed and temperature gradients of a number o Japanese cyclones, and they come out from 30 to 70 per cent. greater than the height of the 'surface layer' as calculated by Dines for England.

INFLAMMABILITY OF COAL DUSTS.—One of the recent publications (Paper 31) of the Safety in Mines Research Board (London: H.M. Stationery Office 1927. 1*s.* 6*d.* net) contains an historical survey of the laboratory methods of determining the inflammability of coal dusts and a preliminary examination of the problems involved in such an investigation. It has been shown that the relative inflammabilities of coa dusts depend on a number of factors, and severa possible methods of determination are discussed The most satisfactory method of comparing the relative inflammabilities is probably the determination of the amounts of inert dust which must be added to prevent the propagation of flame. The advantage of such a method is that the results are immediately applicable to the prevention of explosions in coal mines. Previous determinations by this method have not given results of a high order of accuracy, but it is believed that the sources of error have now been eliminated. The paper, which is the work of A. L. Godbert, serves to indicate the lines on which further research in the Board's laboratories is proceeding.

STRUCTURE OF IRON OXIDE COATINGS.—The process by which a smooth rust- and wear-resisting coating of iron oxides is produced on the surface of iron objects was described by F. S. Barff in 1877. The structure of such a coating, obtained by treating the sample of iron at about 700° with steam and then cooling in air, has been determined by R. M. Bozorth by means of X-ray analysis, using X-rays of different absorption coefficients but nearly equal wave-lengths. The results have been published in the *Journal of the American Chemical Society* for April. The coating consists of layers of ferrous oxide, magnetite, and ferric oxide, and the thicknesses of the layers are estimated to be of the order, 10^{-3} cm., 2×10^{-4} cm., and 2×10^{-5} cm., respectively.

HEAT OF SOLUTION OF SODIUM CHLORIDE.—A new type of adiabatic calorimeter, which can be used with small quantities of material to determine heats of solution over a wide range of concentration with a high degree of accuracy, is described by S. G. Lipsett, F. M. G. Johnson, and O. Maass in the April issue of the *Journal of the American Chemical Society*. The calorimeter consists of a closed silver vessel divided into two compartments. The salt and the solvent are placed in the separate compartments and mixed at the proper moment by rotating the calorimeter. A thermo-couple, which receives its heat by radiation, is employed to ascertain when the outer bath and the calorimeter are at the same temperature. The apparatus has been used to determine the surface energy of solid sodium chloride by measurement of the difference between the heat of solution of ordinary crystalline sodium chloride and that of the finely divided salt at the same concentration. A value for the surface energy of 400 ergs per sq. cm. is given, but owing to the possibility of error in the calculation of the amount of surface, this figure is only approximate.

The Wellcome Historical Medical Museum.

By invitation of Mr. Henry S. Wellcome, a conversazione and meeting of the Royal Anthropological Institute was held at the Wellcome Historical Medical Museum on the evening of May 24. A number of members of the Prehistoric Society of East Anglia, which had held a London meeting at the Royal Anthropological Institute that afternoon, was also present. A cordial message of greeting had been cabled by Mr. Wellcome, who is at present in America, and at his request the guests were received on his behalf by Mr. H. J. E. Peake, president of the Institute, and Mrs. Peake.

A short address on the character and contents of the museum in its anthropological aspect was delivered by Prof. Elliot Smith. Prof. Elliot Smith said that the great museum that Mr. Henry S. Wellcome has created is unique. It affords a concrete demonstration of the history of man's attempts to cope with the fundamental problems of life and death. If such a collection is of interest to physicians and surgeons, it is of vital importance to anthropologists, because it deals with that particular aspect of the study of mankind which is now for the first time coming to be recognised as the central aim of all humanistic inquiry. It illuminates the motives for customs and beliefs, and provides the material for interpreting what is involved in the idea of progress; but it also suggests the explanation of superstition and intolerance.

The fundamental attribute of all living creatures is the fact that they are alive; and their essential reactions serve the purpose of preserving the life that is their distinctive property. In man these instinctive processes receive articulate expression, and to the unconscious reactions for self-preservation are added innumerable devices that are deliberately invented as rational means of preserving and adding to the vital substance. In the Wellcome Museum is displayed a vast collection of charms, amulets, and elixirs of life that have been used by people of every race and clime, and of every time from the upper palæolithic to twentieth-century London, for the purpose of self-protection. As the originally rational excuse for the efficacy of most of these givers of life was shown to be unfounded, many of them still survived in popular estimation, but being stripped of any justification for their reputation, they fall into the category of magic.

Another aspect of essentially the same process is displayed in the practice of mummy-making, the use of relics and magic bundles, and the initiation of medicine-men. Ancient literatures contain accurate reports of the real beliefs of the people of antiquity —that the processes of mummifying the body or making an image of a king conferred upon him a new existence and a new and divine personality, which enhances his powers of conferring safety and prosperity upon every individual among his subjects. The pretence of mummification is the essence of the initiation of a medicine-man, giving him a new name and new powers of life and death; and the symbol of his powers is the magic bundle, which is either the actual mummy or the pretended relic of his predecessor. In the Wellcome Museum are the mummies, the mummified heads, the magic bundles, the graven images, the standards, and the dress of the medicine-men, the amulets, the elixirs of life, the equipment of the astrologers and alchemists, that afford concrete demonstrations of the reality of these things.

The wonderful reproductions in the museum of a chronological series of pharmacies provide a dramatic demonstration of the historical links between the magic of the past and the science of to-day.

Important as the collections of the Wellcome Historical Medical Museum are as an objective record of the history of medicine and the associated sciences, its great value lies in the fact that it affords a demonstration of (and an instrument of research into) the universal problems of human aspirations, and that Mr. Wellcome had this wider vision of its meaning is shown by the fact that he has placed an anthropologist in charge of the Museum.

A vote of thanks to Mr. Wellcome was moved by Lord Onslow and seconded by Dr. Spencer, president of the History of Medicine Section of the Royal Society of Medicine. In putting the vote to the meeting, Mr. Peake emphasised Mr. Wellcome's services to humanity, of which the Museum represented part only. He referred to his work for tropical medicine, especially at Khartoum, and his support of archæological exploration. Starting as a history of medicine, the Museum is becoming more and more anthropological in outlook. He referred also to Mr. Wellcome's judgment, in view of this aspect of the Museum, in selecting Mr. Malcolm, a trained anthropologist, as the conservator of the Museum. In replying on behalf of Mr. Wellcome, Mr. Malcolm emphasised the desire of its founder that it should develop as a Museum devoted to research.

The Production of Pure Chromium, Manganese, and Silicon.

In connexion with the researches on the alloys of iron at present being carried on at the National Physical Laboratory, accounts are given by F. Adcock, Dr. M. L. V. Gayler, and N. P. Tucker in a paper read recently before the Iron and Steel Institute, of the successful attempt to produce three steel-making elements in a state of high purity. It is of interest that each element is prepared by an entirely different type of process. Chromium is made electrolytically, manganese is produced by distillation, and silicon by purely chemical purification.

The chromium was prepared by the electrolysis of an aqueous solution containing 30 per cent. of pure chromic acid and 1 per cent. of sulphuric acid. Lead anodes were used with tin or steel cathodes. Three types of apparatus are described, for one of which, with a steel cathode rotating at a rate of 30 revolutions per minute, the following data are given: The temperature of the bath was 20° C., the voltage 5·2, with an amperage of 140. The current densities at the cathode and anode were 28 amp. and 7·2 amp. per sq. dm., and the yield of chromium in 30 hours was 500 grams, with a current consumption of 8·3 ampere-hours per gram.

All the samples as deposited contained hydrogen and oxygen, the former being liberated during remelting *in vacuo*. The oxygen, which in the cathode chromium is in a form which leaves no residue on solution in acid, is converted on vacuum heating into insoluble chromium oxide (Cr_2O_3). This can be removed, however, by heating the solid metal in pure, dry hydrogen to 1500°-1600° C. (The melting point of chromium is considerably above that of iron, but has not yet been accurately determined.) After these treatments, spectroscopic examination failed to reveal any impurities.

The great hardness of electrolytically deposited chromium, 600-650 Brinell, is apparently caused by the occluded hydrogen, the crystalline form, and possibly the oxygen. It is not possessed by metal of high purity melted or annealed at high temperatures in vacuum or hydrogen, the hardness being then so low as 70 on Brinell's scale.

Manganese of purity 99·3 per cent. may be prepared by the reduction of the oxide by aluminium if the purest available materials are used. Allmand and Campbell's process of production electrolytically from a neutral bath of ammonium and manganese sulphates is also capable of yielding small quantities of the pure metal. By distillation under a pressure of 1 mm.-2 mm. in a high frequency induction furnace at a temperature just above the melting point of the metal, manganese with total impurities less than 0·01 per cent. is readily obtained. The metal thus prepared is silver grey in colour and very brittle. On remelting *in vacuo* the ingot produced is extensively cracked, a phenomenon associated with the critical points which are observed on cooling from fusion. The metal is hard enough to scratch glass and very brittle. When exposed to air it does not tarnish as do ordinary samples of the metal.

The melting point of the manganese has been determined in an atmosphere of hydrogen and is given as 1244°±3° C. Four change points have been observed in the cooling curves at the following temperatures: 1191°, 1024°, 742°, and 682° C. The change at 742° C. appears from the micro-structure to be associated with a change of crystal structure, though no such effect is observed in connexion with that at 682° C. One or both of these changes is accompanied with a marked change of volume.

The method finally adopted for the production of silicon of high purity is as follows: The best available sample of commercial silicon is broken up as small as possible and just covered with water. Strong hydrochloric acid is then added in small quantities at a time, and after the action has quietened down a considerable amount of hydrochloric acid and some nitric acid, and the whole is digested for 24 hours. The impurities, consisting mainly of iron and aluminium silicates and the silicides of iron, calcium, and magnesium, are dissolved. After the necessary washing and filtering the residue is placed in a platinum dish, water added, which is followed by a considerable excess of strong sulphuric acid and small amounts of hydrofluoric acid in small quantities at a time. When all apparent action has ceased, the mixture is evaporated until it fumes. When cool it is digested with water for some hours, filtered and washed. It is again treated with strong hydrochloric acid for several hours, filtered, washed, and dried in a steam oven. The product under favourable conditions contains 99·94 per cent. of silicon and possesses a structure consisting entirely of extensively twinned crystals. F. C. T.

The San Andreas Rift.

IF it were only for its connexion with the Californian earthquake of 1906, the San Andreas rift would be one of the most interesting fault-systems known. The movements that were the cause of that earthquake took place in the northern half of the rift, from San Juan on the south, with three submarine interruptions, to near Cape Mendocino on the north, a total length of about 270 miles. The rift, however, is known to extend more than 300 miles south of San Juan, as far as the desert regions of southern California.

The earthquake of 1906 directed attention to our ignorance of the course of the rift in the latter regions, and, during the past six years, the detailed mapping of the San Andreas fault and the associated fault-zone, together known as the San Andreas rift, has been carried out by Dr. L. F. Noble, of the U.S. Geological Survey. His work is not yet finished, but a report by him of unusual interest on the results already attained is published in the "Year-Book of the Carnegie Institution of Washington" (No. 25, 1925–26, pp. 415-428).

The area studied by Dr. Noble is the southern portion of the rift along the south border of the Mohave Desert and extending across the San Gabriel Mountains into Cajon Pass. The rift here runs in a south-easterly direction and appears as a continuous chain of scarps, trough-like depressions, and ridges, all of which afford clear evidence of recent movements. So straight is the line of the rift that one can see along it for 25 miles or more. Bordering this profound master-fault is a belt of roughly parallel and interlacing fractures, in some places as much as six miles wide. The characteristic features of the rift often change abruptly along its strike. Within half a mile, a scarp may give place to a ridge and the ridge to a trough, or a scarp facing one way may die out and give place to a scarp facing in the opposite direction. The features differ much in size. Some depressions are mere trenches a few feet wide and one or two feet deep. Others are as much as one hundred feet in depth and many hundreds of feet wide. They are in all stages of modification by erosion, either still fresh or almost obliterated. As a rule, the older features are on a much larger scale than those of recent date, indicating that the earlier movements were of the greater magnitude. Some of the recent features point clearly to horizontal movements along the fault. For example, near Cajon Pass, four deep ravines that descend the steep slope of the San Bernandino Mountains on the east side of the rift are displaced abruptly at the fault-trace, each ravine appearing on the west side of the fault at a point at least 150 feet farther to the north-west.

The fault-zone bordering the great fault is a mosaic of elongated blocks, the longer axes of which are parallel to the strike of the fault. In many places the rock-masses are so shattered and different formations are so mixed together that it is impossible to map them. The dominant structure is a sort of slicing that appears to be mainly the result of horizontal shear along the San Andreas fault. Along some of the branching faults are narrow strips of steeply dipping Tertiary sediments pinched between much older crystalline rocks. One of these strips runs for a distance of twelve miles through the highest part of the San Gabriel Range, and in most places does not reach a hundred yards in width.

At but few places in the fault-zone are similar rocks to be found on both sides of the fault. In one portion fifty miles in length, the fault is bordered continuously on the south side by pre-Cambrian schists, while the rocks on the other side are Mesozoic granites and pre-Cambrian gneisses. No clearer evidence of the magnitude of the fault-displacements could be desired.

The first movement along the rift of which the date can be determined approximately occurred between late Mesozoic and early Quaternary times. The different stages of erosion exhibited by the recent, sub-recent, and older topographic features along the rift prove that faulting has taken place at intervals all through Quaternary time and that it has not yet come to an end. C. D.

University and Educational Intelligence.

Cambridge.—The following appointments have been made: Mr. F. Debenham, Gonville and Caius College, to be reader in geography; Mr. T. G. Bedford, Sidney Sussex College, to be lecturer in physics; Dr. E. M'Kenzie Taylor, St. John's College, to be lecturer, and Dr. H. E. Woodman, demonstrator in agricultural chemistry; Mr. T. K. W. Fair, Jesus College, to be demonstrator in agricultural physiology, and Mr. W. A. Wooster, Peterhouse, to be demonstrator in mineralogy.

K. R. H. Johnston, Sidney Sussex College, A. C. Candler, Trinity College, and G. A. Bell, St. John's College, have been elected to the Henry P. Davison scholarships at Harvard, Yale, and Princeton Universities respectively.

It is proposed to establish new lectureships in structural crystallography in the department of mineralogy and in cultural anthropology in the faculty of archæology and anthropology. It is also proposed to build a special animal house to provide facilities for studying the metabolism of pigmented animals, a capital grant for the purpose having been offered by the Empire Marketing Board.

London.—A research studentship, value £100, is being offered by Bedford College for Women to graduates of the college of not more than three years' standing. Particulars are obtainable from the Secretary.

Oxford.—The Preamble to a form of Statute providing that women shall be eligible to any professorship, readership, or other university teachership, has been approved by Congregation.

The University Observatory is to be extended at a cost not exceeding £2750, and Prof. H. H. Turner's eport on the work of the Observatory for the period May 1, 1926-Mar. 1, 1927, has been published. The various activities of the institution include the well-known seismological investigations by Prof. Turner and a research on "'Trepidation,' or the Fluctuation in the Solar System," by Dr. J. K. Fotheringham.

St. Andrews.—Prof. H. J. Rose, professor of Latin ince 1919 at Aberystwyth, has been appointed professor of Greek in the United College. Prof. Rose graduated at McGill University, Montreal, in 1904; he was appointed Rhodes Scholar from the Province of Quebec and went to Balliol College, Oxford. Prof. Rose has published volumes on "The Roman Questions of Plutarch," "Primitive Culture in Greece," and 'Primitive Culture in Italy."

The Royal Society announces that the secretaries are prepared to receive applications for the Mackinnon and Moseley Research Studentships, which are each of the annual value of £300. The appointments will, n the first instance, be for two years, but may be extended. Particulars and forms of application can be obtained from the assistant secretary of the Society, Burlington House, W.1. The completed orms must be returned by June 22 at latest.

Two vacation courses to be held during the coming August are being organised by Leplay House. One will be held in the High Pyrenees, with Aix-les-Thermes as its principal centre. The other will be a students' camp' in the Austrian Tyrol in Aldrans, 700 feet above Innsbruck. The courses are open to ll university lecturers, teachers, students, and others nterested in geographical, historical, and social tudies. Particulars may be obtained from Leplay House, 65 Belgrave Road, Westminster, S.W.1.

Calendar of Discovery and Invention.

June 5, 1838.—In the Journal of Caroline Fox, under this date is an entry describing a visit to King's College, London, to see Wheatstone's electric telegraph, which "is really being brought into service, as last week they began laying it down between London and Bristol, to cost £250 a mile. . . . Wheatstone has been giving lectures, and in fact is in the middle of a course. No ladies are admitted, unfortunately; the Bishop of London forbade it; seeing how they congregated to Lyell's, which prohibition so offended that gentleman that he resigned his professorship."

June 5, 1854.—More than seventy years ago, James Bowman Lindsay conceived the idea of signalling through water without wires, making experiments in the Tay, at Portsmouth and elsewhere; and on June 5, 1854, he took out a patent for "a mode of transmitting telegraphic messages through and across water without submerged wires, the water being made available as the connecting and conducting medium."

June 6, 1761.—Transits of Venus across the sun's disc occurred in 1631 and 1639, 1761 and 1769, and in 1874 and 1882. That of 1631, though predicted, was unobserved, while Horrocks and Crabtree, two young English astronomers, were the sole observers of that of 1639. The transit of June 6, 1761, was the first to be observed by astronomers generally and many described it, while the transits of the last century were utilised to determine the solar parallax.

June 7, 1866.—On this day Francis Herbert Wenham, one of the early pioneers of flight, took out his patent, No. 1571, for improvements in apparatus for aerial navigation. His patent included "a novel arrangement of surfaces placed one above the other and kept in parallel planes by means of cords or rods or webs of woven fabric," this system of surfaces being arranged as a suitable structure for containing the motive power.

June 8, 1829.—The collaboration between Liebig and Wohler was the outcome of a proposal by the latter. The two had met at a friend's house in Frankfort, and on June 8, 1829, Wöhler wrote to Liebig from Sacrow, near Potsdam: "If you are so minded, we might, for the humour of it, undertake some chemical work together, in order that the result might be made known under our joint names. Of course, you would work in Giessen and I in Berlin, when we are agreed upon the plan, and we could communicate with each other from time to time as to its progress."

June 9, 1810.—The compound steam engine was brought into use by Woolf, who on June 9, 1810, took out a patent "for further improvements in the construction and working of steam engines." In a Woolf engine, steam was used expansively in the high-pressure cylinder and then passed direct to the low-pressure cylinder without an intermediate receiver. Woolf engines were considerably more economical than those previously used.

June 9, 1881.—One of the inventions which aroused the enthusiasm of Lord Kelvin was the improved form of secondary battery brought out by Faure. Many experiments were carried out at Glasgow, and in a letter to the *Times* on June 9, 1881, entitled "Electrical Storage of Dynamical Energy," Kelvin directed attention to the importance of the new form of accumulator.

June 10, 1717.—The "Sermo de structura florum" of Sébastien Vaillant (1669–1722) was read in Paris at the opening of the Jardin Royal de Paris, and afterwards published in Latin and French, the perusal of this thin volume is stated to have suggested his sexual system of plants to Carl Linnæus (1707–1778) ten years later.

E. C. S.

Societies and Academies.

LONDON.

Physical Society, April 8.—**C. L. Fortescue**: The characteristics of thermionic rectifiers. Rectifying valves working at low voltages with unsaturated electron currents are discussed. The most economic conditions are briefly dealt with; so far as the limited information with respect to the life of modern valves is concerned, it is probable that long life should be provided for.—**B. L. Worsnop**: The scattering of X-rays and the *J* phenomenon. Experiments have been carried out using a 'balance method' to obtain the *J* discontinuity which Barkla found with heterogeneous X-rays scattered by elements of low atomic weight; no such discontinuities have been found. Probably some condition which has not yet been published is required for its production.—**Ezer Griffiths**: A carbon dioxide measuring instrument based on sound velocity measurement. A quartz crystal is maintained in vibration piezo-electrically, and stationary waves are set up in the gas between the flat surface of the crystal and a movable reflector. The position of the nodes is recognised by the reaction on the quartz crystal, resulting in an increase of the current in the maintaining circuit. The distance from node to node is a measure of the composition of the gaseous mixture, assuming it is composed of two gases which do not react.

Geological Society, April 27.—**F. W. Shotton**: The conglomerates of the Enville Series of the Warwickshire Coalfield. The conglomerates are found at three horizons, to which, in descending order, the names of Allesley, Corley, and Arley-Exhall have previously been applied. The derived pebbles consist chiefly of dark Valentian sandstone, carboniferous limestone, and carboniferous chert. Igneous material is extremely rare. The Arley-Exhall pebbles are mainly carboniferous cherts, with less abundant limestone and Valentian sandstone; while the Corley materials are predominantly Valentian, with some chert, but limestone is very rare among them. The Valentian pebbles of the Arley-Exhall conglomerate were probably derived from the west, whereas similar material at the Corley horizon came from the east. It seems most reasonable to suppose the previous existence of Upper Valentian deposits upon the present north-to-south underground extension of the Nuneaton ridge. The limestone-pebbles of the Corley conglomerate may have come from the west or from the south-west.—**F. C. Phillips**: The serpentines of the Shetland Islands, and the associated rocks and minerals. The Shetland Islands consist mainly of a series of schists and paragneisses, with a strike over the greater part of the area of about north 10° east, and a steep westward dip. Around the eastern and western margins of Mainland occur patches of Old Red Sandstone sediments, and on the north an extensive development of igneous products of that age. A series of old intrusions, ranging from ultrabasic to acid, is found among the metamorphic rocks. The most basic of these earlier intrusions, chiefly developed in the northernmost islands of Unst and Fetlar, was a dunite, now almost entirely serpentinised. A constant accessory in these rocks is a chromespinel, and in places this becomes concentrated as workable deposits of chromite. The ores are of two main types: banded chromite-serpentine and lenticles of massive chromite-rock. The gabbro, succeeding on the east, is extensively altered, the original pyroxene being uralitised and the felspar converted to a saussuritic aggregate. Later mineralogical and chemical changes have been brought about by dynamic metamorphism and low-temperatur weathering.

Linnean Society, April 28.—**Hugh Scott**: Narrativ of an expedition to Abyssinia. The journey wa undertaken to examine the insect fauna and, s far as possible, the flora of the highlands of centra Abyssinia. The fauna and flora are of peculia interest in that they are those of a large well watered, elevated country in the heart of Africa isolated from surrounding regions by low-lying deser or semi-desert tracts; and that they exhibit a remarkable blend of Palæarctic, Ethiopian, and Orienta elements. The Expedition set out from Addis Ababa the capital, at more than 8000 feet above sea-level, and several very different types of country, lying a elevations between 5500 and 12,000 feet, were visited These included the primeval forest of Djem-Djem composed mainly of giant juniper-trees; Moun Zuquála, an extinct volcano with a lake in its crater and carrying giant heath; the plains southwards t Lake Zwai, a region of dry bush and thorn-scrub the park-like country, forest, and heath-land of Moun Chillálo; and the Muger Valley, a great chasm more than 2000 feet deep, with precipitous sides. A curiou mixture of temperate and distinctly African plants was frequently met with.—**W. P. Pycraft**: Restoration of the left innominate bone of Rhodesian man The restoration is based on the greater part of the left ilium. That portion of the ilium forming the outer wall of the 'false-pelvis' is remarkable for its great height and the quite unusual position o the greater sciatic notch. The acetabulum of the fragment is remarkably small and shallow, and the form of its articular surface is unusual. What answers to the lower segment of the horse-shoe loop in modern pelves is splayed out backwards so as to cause the acetabulum to look backwards and downwards instead of forwards and outwards as in modern man The position of the ischium and pubis is markedly different from that of modern pelves.

Society of Public Analysts, May 4.—**W. R. Schoelle and C. Jahn**: Investigations into the analytica chemistry of tantalum, niobium, and their minera associates. (vii.) The precipitation of tungstic acid by tannin. (viii.) The separation of tungsten from tantalum and niobium. Small quantities of tungstic acid are quantitatively recovered from tungsten solutions containing alkali chloride by precipitation with tannin and cinchonine hydrochloride. A method of determining small amounts of tungsten in the presence of large amounts of earth acids has been based on this principle. Small amounts of earth acids in tungstic trioxide are determined by fusing the mixture with sodium hydroxide and treating the fused mass with sodium chloride solution; sodium tantalate and niobate remain undissolved.—**S. G. Clarke**: The separation of vanadium and tungsten. Vanadium may be determined in the presence of large amounts o tungsten by precipitation with cupferron (ammonium salt of nitroso-phenyl hydroxylamine) after treatment of the solution with hydrofluoric acid, neutralisation with ammonia, addition of hydrochloric acid, and dilution. The precipitate is separated, washed, and ignited at a low temperature, the residual vanadium pentoxide dissolved in dilute sulphuric acid, and the solution reduced with sulphur dioxide and titrated with permanganate.—**J. M. Jones and T. McLachlan** The determination of moisture by the volatile solvent method. The method is satisfactory for emulsions such as butter and margarine, and gives more consistent results than any other method for such products as jam, honey, and malt extract. The use o toluene as a solvent enables the results to be obtained in a shorter time than when benzene or petroleum spirit is used.—**F. Wokes** and **S. G. Willmott**: A study of antimony trichloride as a possible quantitative reagent for vitamin A. The reaction is probably due to condensation, and can be retarded by dehydration of the solvent. The depth of the initial blue coloration obtained under standard conditions may be used to measure the vitamin A content of the oil. The intensity of colour is expressed in Lovibond blue units 30 seconds after mixing the solution of the oil and reagent.—**B. S. Evans**: New processes for the determination of certain elements in lead. The sample is dissolved in nitric acid, lead separated as sulphate, and arsenic precipitated with sodium hypophosphite and separated by shaking with benzene and filtering. Antimony is determined in the filtrate, and the arsenic in the precipitate is determined by an iodimetric method. Bismuth is determined colorimetrically with potassium iodide after separation of the lead as sulphate and chloride, and sulphur is determined gravimetrically after dissolving the metal in *aqua regia*, evaporating the solution to dryness, and dissolving the residue in dilute hydrochloric acid.

Optical Society, May 12.—**M. von Rohr**: Contributions to the history of English opticians in the first half of the nineteenth century (with special reference to spectacle history). Although London opticians during the eighteenth century had carried out splendid work as craftsmen, they were not very quick at adopting new ideas. This was a great drawback, especially as about 1818, Fraunhofer succeeded in raising the standard of his factory to an unrivalled height. Although Fraunhofer's innovations do not seem to have had any direct influence on English opticians, they were acknowledged by English men of science. Strenuous endeavours were made between 1826 and 1829 by Sir John Herschel and Michael Faraday to produce optical glass, and theoretical work was carried out by Airy, Coddington, and Hamilton. London opticians, however, did not derive the same amount of help from such scientific innovations as the Vienna school did from Stampfer and Prechtl, and the good fortune of securing Petzval's help gave, in 1840, the leading position in the manufacture of photographic lenses of high aperture to the Viennese firm of Voigtlander. The inventions of stereoscopy and photography presented opticians with new problems, and English amateurs were the first to understand photographs as perspectives of the depicted object. At the end of the period a well-directed optical glass factory was established in England.

Royal Meteorological Society, May 18.—**Harold Jeffreys**: Cyclones and the general circulation. If there were no variation of temperature with latitude, the atmosphere could rotate with the earth like a rigid body, and this would be a stable state. But increase of temperature towards the equator implies that the velocity from the west must increase with height, and in these conditions frictional interaction between different layers of the air and between the lowest layer and the ground would suffice to destroy any motion symmetrical about the earth's axis. Irregular horizontal interchange of air must therefore be developed, and this implies the known system of cyclones. One effect of the interchange would be that the normal winds at the surface must be on the whole as much easterly as westerly; the easterly prevailing winds are near the equator and the westerly ones in higher latitudes. This mechanism would give slow anticyclonic circulations near the poles, apart from possible local conditions.—**George M. Meyer**: Early water-mills in relation to changes in the rainfall of east Kent. Records of water-mills in Domesday and in mediæval law-suits show that the streams of the district were of greater volume at the end of the eleventh century than to-day, and that the decrease was rapid about 1275. Early in the fourteenth century, silt was carried down by the Gestling or North Stream, whereas now practically none is brought down by that stream or by the Stour near its mouth. Indeed, the varying discharge of the streams represents approximately the changes in the rainfall. These variations had a profound effect upon the silting up of local harbours, a point which may well affect the choice of site for any prospective new harbour.—**S. Morris Bower**: Report on winter thunderstorms in the British Islands from January 1 to March 31, 1926. The widespread thunderstorms about Feb. 16, 1926, which appear to have accompanied the passage of five squall lines, are specially treated. Figures showing the diurnal variation in the frequency of winter thunderstorms in 1925 and 1926 are included.

PARIS.

Academy of Sciences, April 20.—**André Charrueau**: A figure of equilibrium, of revolution, of a liquid mass in rotation, submitted to a Newtonian attraction between its particles and to the surface tension.—**V. Dolejšek**: The systematics of the X-rays.—**P. Brun**: The surface tension of liquid mixtures in the neighbourhood of the critical state. Studies in the critical temperatures of miscibility of liquids. Measurements of surface tensions of aqueous ethyl alcohol and isoamyl alcohol.—**Herzfinkel**: The elements with atomic numbers 43, 61, 75, 85 and 87. Historical account of searches for these elements.—**Robert Stumper**: The thermal analysis of the dehydration of gypsum. The temperature of formation of calcium sulphate semihydrate is higher as the velocity of dehydration increases, but the temperature of formation of anhydrite is practically uninfluenced by this factor, at least within the limits of the velocities studied.—**J. F. Durand** and **M. Banos**: The addition of acetylene to carbon monoxide: the synthesis of quinone. Mixtures of carbon monoxide and acetylene treated with cuprous chloride in hydrochloric acid or ammonia solution gave no results, but in pyridine solution a reaction takes place from the products of which *p*-quinone was isolated.—**L. Dollé**: The hydrogeology of chalk.—**P. Chevey**: The transitory vascular networks of the spawn of *Acara tetramerus*.—**J. Chaine** and **J. Duvergier**: The distinction between *Gadus capelanus*, *minutus* and *luscus* by their sagitta.

April 25.—**Maurice Hamy**: The measurement of the radial velocities of the stars.—**Jean Perrin** and **Mlle. Choucroun**: The rôle of molecular induction in activation by shock.—**R. de Forcrand**: Researches on the thallous carbonates. Thermochemical data for thallium carbonate.—**Erhard Tornier**: The properties of the prime numbers explained by the theory of probabilities.—**Emile Borel**: Remarks on the preceding communication.—**A. Kovanko**: The integration of series of totalisable functions.—**Louis Barbillion**: The true period of direct governors.—**Haroutune Anjour**: A new method for studying the movement of a solid body.—**Charles Frémont**: The cause of the cupel formation in the breaking of certain test pieces by traction.—**P. David**: Detection (in wireless telegraphy) by the valve.—**Georges Balasse**: The electrodeless discharge in damped waves or maintained waves. The continuous spectra of cæsium and potassium.—**Mme. L. François-Franck**: An arrangement for biological photomicrography and kinemamicrophotography. A diagram in plan and elevation of the proposed apparatus is given.—Emile **Rousseau**: The photochemical action of the mercury vapour arc on a liquid containing formaldehyde covered with olive oil.—Edmond **Vellinger**: The rotatory power of tartaric acid. Reply to a criticism by L. Longchambon.—Const. A. **Kténas**: The enclosures and endomorph lavas of Fouqué-Kaméni.—G. **Nicolas**: New biological observations on *Fegatella conica*.—G. **Nadson**: The perforating algæ, their distribution and their rôle in Nature. These perforating algæ are very widely distributed, and develop in great quantities in many seas. They perforate calcareous substances from the delicate teguments of the Bryozoa up to the hardest limestone rocks. Their action, although scarcely visible on cursory examination, is on a very large scale and has important results on the circulation of calcium on the earth's surface.—René **Souèges**: The embryogeny of the Leguminoseæ. The development of the proembryo in *Trifolium minus*.—A. **Sartory**, R. **Sartory**, and J. **Meyer**: Researches on the causes of the appearance of the perithecium in *Aspergillus fumigatus*.—R. **Fosse** and Mlle. N. **Rouchelmann**: The action of pulped liver on ammonium cyanate.

CAPE TOWN.

Royal Society of South Africa, Mar. 16.—J. M. **Watt** and Marie G. **Brandwijk**: On *Xysmalobium undulatum*—a chemical and pharmacodynamical study of 'Chonga' (Bitter-wortel). This drug is used in South Africa as an intestinal and uterine sedative.—C. G. S. **de Villiers**: The comparative anatomy of the breast-shoulder apparatus of the three aglossal anuran genera Xenopus, Pipa and Hymenochirus. It is considered that Xenopus and the Hymenochirus group will prove to be more closely allied with each other than with Pipa, but in the absence of any developmental material of Hymenochirus, the mutual relationships of the Ethiopian Aglossa remain a matter of pure speculation.—G. A. H. **Bedford**: Description of three new species of Anoplura from South African mammals. The new species are named *Linognathus taurotragus* (from eland), *Linognathus gnu* (from black wildebeest or gnu), and *Linognathus ferrisi* (from blue wildebeest).—Sir Thomas **Muir**: Note on hyperorthogonants. Sylvester's suggested generalisation of the original conception of an orthogonant, although neglected for a generation, has, since Hadamard recalled it to notice in 1893, received considerable attention. The same does not hold in regard to a second generalisation (the hyperorthogonant) which is of quite a different type and not improbably may prove the more important of the two. Use was first made of a hyperorthogonant in a paper by Petrini in 1901.

MELBOURNE.

Royal Society of Victoria, Mar. 17.—Alfred J. **Ewart** and Phyllis **Jarrett**: Contributions to the flora of Australia (No. 33). Additions to the flora of the Northern Territory. Further examinations have been made of material collected by the senior author in Central Australia, as well as of Mr. Allan's Northern Territory collections and of material in the Tate Herbarium, Adelaide. The genus Wycliffea is merely a highly cleistogamic form of *Glinus Spergula*. The paper contains 15 additions to the flora and 80 locality records.—H. M. **Treloar**: Variation of wind with height at Melbourne when geotropic winds are northerly. The mean change of wind with height in a particular class of Melbourne winds is considered, and close agreement shown to exist between computed and observed winds between the heights 50 m. and 800 m. Values of the eddy diffusivity for different parts of this height range are derived. In computing the theoretical wind distribution, difficulties associated with the use of the usual boundary conditions are avoided by applying certain determining conditions at a definite height, which height is found from the observations.—Alice M. **Coverlid**: The leaves of *Grewia polygama*. A decoction made by pouring boiling water over the leaves of this plant, which is a member of the order Liliaceæ, is used by white people throughout the Northern Territory and the north of Queensland, where it grows, as a remedy for dysentery. Examination showed nothing to which its alleged properties could be ascribed, except tannins, and these were present only to the extent of 4 per cent. of the dry weight of the leaves. The aborigines, credited with knowing any native plant of medicinal value, do not use this plant.—Arthur M. **Lea**: Australian Curculionidæ of the subfamily Gonipterides. The paper deals with a subfamily of Australian weevils which feed principally on eucalyptus leaves. Notes are given on synonymy, variation and distribution, and twenty species are described as new. One of the species, *Gonipterus scutellatus*, was accidentally introduced to South Africa, South America, and New Zealand, where it has become so abundant that the 'blue,' 'manna,' and other gums are threatened with destruction. The South African Government recently sent an entomologist to Australia, where he found a minute wasp that destroys its eggs, and this has been successfully introduced to South Africa.

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, vol. 13, No. 3, March).—Carl **Barus**: Pinhole probe experiments with massive air columns. The acoustic pressures inside a conical horn were investigated. The curve showing the relation between pressure and depth in the horn is practically a straight line except at the mouth and base of the horn.—William V. **Houston**: The fine structure of the helium arc spectrum. A low current density was used and the discharge tube was cooled in liquid air. A compound Fabry-Perot interferometer was used for the diffuse series line λ5876 and gold films on the simple interferometer for the sharp series line λ7065. By these means it was shown that the helium spectrum has a triplet structure similar to that predicted by Heisenberg.—Paul S. **Epstein**: Two remarks on Schrödinger's quantum theory. The first relates to the relativity effect in the neutral hydrogen atom; the second deals with the theory of light quanta.—Boris **Podolsky**: On King's classical theory of radiation. Objections are raised that if the electron behaves as a rigid body and acquires a precession, it cannot absorb energy and maintain the frequency of precession, and also that a spinning electron moving with uniform translational velocity cannot have a precession.—H. **Sponer**: Absorption bands in nitrogen. The ultra-violet band system found by Birge and Hopfield in emission is a true absorption system of nitrogen.—J. C. **Slater**: Action of radiation and perturbations of atoms.—George B. **Welch**: The periodicity of photo-electric thresholds. As might be expected if the photo-electric threshold is a measure of the energy from incident radiation required to detach an outer electron, the threshold-atomic number curve is periodic with maxima for the alkali metals. The value for gold is anomalous.—L. F. **Heimlich**: Microsporogenesis in the cucumber.—Sophia **Satina** and A. F. **Blakeslee**: Further studies on biochemical differences between sexes in plants. Extracts of female plants are generally stronger reducers of potassium permanganate than extracts from male plants. The results are closely parallel with those of the Manoilov reaction, but the reducing substances effective in the two cases are different. The reactions depend on quantitative rather than qualitative differences.—E. M. East: Inheritance of trimorphism in *Lythrum salicaria*. Self-sterility is not due to selective pollen-tube growth. The two kinds of pollen carry the same factors so far as trimorphism is concerned. Flower differences are conditioned by three genes, long style being recessive.—F. G. Benedict and E. G. Ritzman: (1) The fasting of large ruminants. Four steers have been subjected to fasts of 5 to 14 days. Records were obtained of changes of body-weight, amount of excreta, gaseous metabolism, and so on. The total carbon dioxide production in consecutive half-hour periods was measured in a respiration chamber. During the fast, the character of the urine changes from that of herbivora to that of omnivora and nitrogen excretion increases. Heat production (determined from the carbon dioxide production and respiratory quotient) decreases, at first rapidly and then more slowly. Metabolism depends on the previous feeding (maintenance or sub-maintenance) and is notably higher in young animals. (2) The basal metabolism of steers. The effect of the temperature of the environment is small. The metabolism reaches a steady value about 30 hours after the last feed. Respiration experiments during four consecutive half-hour standing periods and during 24-hour periods when the animal stood or laid down at will showed that posture has little effect. The true basal metabolism is 1300 + calories per square metre of body surface, which is 40 per cent. greater than that of man. (3) The metabolic stimulus of food in the case of steers. Animals fasted for two days and then given a ration low in protein all showed a great increase of metabolism consequent on the ingestion of food. Any additional activity during feeding periods and 'the work of digestion' required by the movements of food masses through the intestines cannot account for the increased metabolism observed. It is suggested (after Grouven) that carbohydrates in the ruminant are fermented to form fatty acids and are wholly absorbed at this stage; these acids in the blood stimulate cell activity.—Leonell C. Strong: Studies on the effect of potassium alum-hydrochloric acid solutions on the growth and fate of neoplastic tissue. (1) Effect on a slow-growing adeno-carcinoma of the mouse. A stock of mice the females of which develop spontaneous mammary gland cancer has been produced. Potassium alum in hydrochloric acid was given in the drinking water, and it so affects the host or the tumour that the growth of the later is definitely slowed down and the host animal is able to live longer than it would if untreated. Complete regression of spontaneous tumours has been observed after combined oral administration and subcutaneous injection.—C. F. Roos: Dynamical economics. Competition, monopoly, and co-operation in general functions of demand and cost are discussed mathematically.—Edwin B. Wilson: On the proof of Sheppard's corrections.—D. V. Widder: Note on a generalisation of Taylor's series.—George D. Birkhoff: (1) A theory of matter and electricity. The theory requires the introduction of a 'substance coefficient' and an 'atomic potential' and it is claimed that it satisfies the demands of determinateness and stability.—(2) The hydrogen atom and the Balmer formula. By the use of the theory put forward in (1), a formula of the Balmer type is obtained.—G. A. Miller: Groups generated by two operators of order three whose product is of order three.

Official Publications Received.

British.

Annual Report of the Council of the Yorkshire Philosophical Society for the Year 1926, presented to the Annual Meeting, February 21st, 1927. Pp. 41+16. (York.)

British Chemical Abstracts issued by the Bureau of Chemical Abstracts. Index, 1926. Pp. 430. (London: Society of Chemical Industry.)

The Physiological Society. Session 1927–8. Rules, List of Members and Dates of Meetings. Pp. xii+32 (London.)

Transactions of the Faraday Society. Index, Vols. 1 to 20. Pp. 56. (London and Edinburgh: Gurney and Jackson.) 13s. 6d. net; paper, 10s. 6d. net.

Union of South Africa: Department of Agriculture. Bulletin No. 11: Cheddar Cheese-making. By Jas. P. Gow. Pp. 16. (Pretoria: Government Printing and Stationery Office). 3d.

Union of South Africa. Report of the South African Museum for the Year ended 31st December 1926. Pp. ii+13. (Cape Town.)

Board of Education. Report on the Science Museum for the Year 1926. Pp. 27. (London: H.M. Stationery Office.) 1s. net

The University of Leeds: Department of Leather Industries. Report of the Advisory Committee on the Work of the Department during the Sessions 1924–25 and 1925–26. Pp. 8. (Leeds.)

The Scientific Proceedings of the Royal Dublin Society. Vol. 18 (N.S.), No. 37: The Soluble Silicate Content of Soils. By W. R. G. Atkins. Pp. 433-436. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 6d.

Falmouth Observatory. Meteorological Notes and Tables for the Year 1926. By Joshua Bath Phillips. Pp. 11. (Falmouth)

Proceedings of the Cambridge Philosophical Society. Vol. 23, Part 6, April. Pp. 617-754. (Cambridge: At the University Press.) 7s. 6d. net.

The Physical Society. Proceedings, Vol. 39, Part 3, April 15. Pp. 171-260. (London: Fleetway Press, Ltd.) 6s. net.

The North of Scotland College of Agriculture. Bulletin No. 32: Crane Fly Grub and the Oat Crop. By John Rennie. Pp. 14. Bulletin No. 33: Acarine Disease in Hive Bees, its Cause, Nature and Control. By John Rennie Pp. 34+5 plates. 1s. (Aberdeen.)

Electricity Commission. Electricity (Supply) Act, 1926. Central Scotland Electricity Scheme, 1927. Scheme prepared by the Electricity Commissioners in pursuance of Section Four of the Electricity (Supply) Act, 1926. Published by Order of the Central Electricity Board. Pp. 10+1 map. 1s. net. Supplementary Particulars. Pp. 75+4 diagrams. 2s. 6d. net. (London: H.M. Stationery Office)

The Journal of the Institution of Electrical Engineers. Edited by P. F. Rowell. Vol. 65, No. 365, May. Pp. 469-552+xxx. (London: E. and F. N. Spon, Ltd.) 10s. 6d.

Forest Bulletin No. 68: Notes on the Comparative Economic Cost of Wood and Metal Sleepers in India, and Cost of Treatment. By J. H. Warr and H. Trotter. (Economy Series.) Pp. v+29+8 plates. 1.12 rupees; 3s. Forest Bulletin No. 70: *Hoplocerambyx spinicornis*—an important Pest of Sal. By D. J. Atkinson. (Entomology Series.) Pp ii+34+5 plates. 15 annas; 1s. 6d. (Calcutta: Government of India Central Publication Branch.)

Journal of the Indian Institute of Science. Vol. 9A, Part 9: Derivatives of Naphthaquinolines and Naphthaisoquinolines. By Charles Stanley Gibson, Kalvoi Venkatakrishna Hariharan, Kottiazath Narayana Menon and John Lionel Simonsen. Pp. 179-191. 12 annas. Vol. 9A, Part 10: i. Isomeric Phenylisatines; ii. The Unstable Modification of isoNitrosocamphor; iii. d-Mannitol from 'Gardenia turgida.' By M. O. Forster and Keshaviah Aswath Naram Rao. Pp. 193-207. 12 annas. (Bangalore.)

Publications of the Dominion Astrophysical Observatory, Victoria. Vol. 3, No. 15: The Orbits of three A-type Spectroscopic Binaries. By W. E. Harper. Pp. 315-329. Vol. 3, No. 16: Two Spectroscopic Binary Orbits. By R. M. Petrie. Pp. 331-339. Vol. 3, No. 17: Two K-type Spectroscopic Binaries. By W. E. Harper. Pp. 341-348. (Victoria, B.C.)

Publications of the South African Institute for Medical Research. No. 20: The Plague Problem in South Africa; Historical, Bacteriological and Entomological Studies By J. Alexander Mitchell, Dr. J. H. Harvey Pirie and Dr. A. Ingram. Pp. 85-256. (Johannesburg.)

Aeronautical Research Committee: Reports and Memoranda. No. 1062 (E. 23): Dopes and Detonation. Second Report by Prof. H. L. Callendar. Experiments made in the Air Ministry Laboratory at the Imperial College of Science, London, under the Direction of R. O. King, by Dr. E. W. J. Mardles and W. J. Stern, assisted by N. R. Fowler. (B.4. Engines, 62.—T. 2372.) Pp. 31+5 plates. 1s. 3d. net. No. 1069 (Ae. 251): On a Modification of the Chattock Gauge, Designed to Eliminate the Change of the Zero with Temperature. By W. J. Duncan. (C.1. Accessories-Instruments, 93.—T. 2308.) Pp. 5+1 plate. 6d. net. No. 1074 (Ae. 256): Full Scale Tests of a Suspended Air Log. By J. K. Hardy. (C.1. Accessories-Instruments, 94.—T. 2391.) Pp. 4+1 plate. 4d. net. (London: H.M. Stationery Office.)

The Scientific Proceedings of the Royal Dublin Society. Vol. 18 (N.S.), No. 36: On the Index Fossil of the *Cleistopora* Zone. By Dr. Louis B. Smith. Pp 423-431+plates 20-22. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 2s. 6d.

Bishop's Stortford College. Report of the Proceedings of the Natural History Society, 1926. Pp. 22. (Bishop's Stortford.)

Foreign.

Koninklijk Magnetisch en Meteorologisch Observatorium te Batavia. Verhandelingen No. 19: Monsoon-Currents in the Java Sea and its Entrances. By H. P. Berlage, Jr. Pp. 28+21 plates. (Weltevreden: Landsdrukkerij.)

Report of the Aeronautical Research Institute, Tôkyô Imperial University. No. 20: On the Mechanism of Cyclones and Anticyclones, Part 2. By Tatuo Kobayasi. Pp. 205-223. 0.50 yen. No. 21: Lower Limit of Inflammability of Ethyl Alcohol, Ethyl Ether, Methyl Cyclohexane and their Mixtures. By Yoshio Tanaka, Yumiburo Nagai and Kinsei Akiyama. Pp. 225-246. 0.25 yen. (Tôkyô: Kôseikai Publishing Office.)

United States Department of Agriculture. Department Bulletin No. 1469: The Satin Moth, a recently introduced Pest. By A. F. Burgess and S. S. Crossman. Pp. 23+1 plate. (Washington, D.C.: Government Printing Office.) 10 cents.

Department of Commerce: U.S. Coast and Geodetic Survey. Serial No. 378: Tables for Albers Projection. By Oscar S. Adams. (Special Publication No. 130.) Pp. ii+24. (Washington, D.C.: Government Printing Office.) 5 cents.

Department of the Interior: Bureau of Education. Bulletin, 1927, No. 1: Record of Current Educational Publications, comprising Publications received by the Bureau of Education to January 1, 1927. Pp. 58. (Washington, D.C.: Government Printing Office.) 10 cents.

Proceedings of the United States National Museum. Vol. 70, Art. 18. Small Shells from Dredgings off the Southeast Coast of the United States by the United States Fisheries Steamer *Albatross* in 1885 and 1886. By William H. Dall (No. 2667) Pp. 134. Vol. 70, Art. 23: A Revision of the Beetles of the Genus Oedionychus occurring in America north of Mexico. By Doris Holmes Blake. (No. 2672.) Pp. 44+2 plates. Vol. 71, Art. 11: Notes on the Melitæid Butterfly *Euphydryas phaeton* (Drury), with Descriptions of a new Subspecies and a new Variety. By Austin H. Clark. (No. 2682.) Pp. 22+5 plates. (Washington, D.C.: Government Printing Office.)

Smithsonian Institution: United States National Museum. Report on the Progress and Condition of the United States National Museum for the Year ended June 30, 1926. Pp. ix+205. (Washington, D.C.: Government Printing Office.) 25 cents.

Proceedings of the Academy of Natural Sciences of Philadelphia. Vol. 78, 1926. Pp. iii+506+40 plates+128. (Philadelphia, Pa.)

Department of Commerce: Bureau of Standards. Technologic Papers of the Bureau of Standards, No. 337: Soundproofing of Apartment Houses. By V. L. Chrisler. Pp. 253-260. (Washington, D.C.: Government Printing Office.) 5 cents.

Bulletin of the American Museum of Natural History. Vol. 53, Art. 2: The Aquatic Mollusks of the Belgian Congo, with a Geographical and Ecological Account of Congo Malacology. By Henry A. Pilsbry and J. Bequaert. Pp. 69-602+plates 10-77. (New York City.)

Diary of Societies.

SATURDAY, June 4.

Institution of Municipal and County Engineers (South-Eastern District Meeting) (at Town Hall, Maidstone), at 11 A.M.—T. F. Bunting: Housing in Borough of Maidstone; Widening of Maidstone Bridge; New Elementary School.

Oxford University Junior Scientific Club, at 8.15.—Sir Leonard Rogers: Climate and Disease Incidence in India: Forecasting Epidemics.

Institution of Municipal and County Engineers (Scottish Meeting) (at Dunfermline).

MONDAY, June 6.

Royal Society of Edinburgh, at 4.30.—Prof. Harvey-Gibson: Account of the Life of De Saussure 1767–1845, with the gift of the MSS. of a Translation of his "Recherches chimiques sur la végétation," 1804.—Ethel Currie: Fossil Echinoides of Somaliland.—A. Calder: A Case of Partial Sex Transformation in Cattle.—W. O. Kermack and W. T. H. Williamson: Stability of Suspensions, Part 2, The Rate of Sedimentation of Kaolin Suspensions containing Colloidal Silicon Dioxide.—Amy Fleming: The Peripheral Sympathetic Innervation of the Uterus (*to be read by title*).—W. L. Ferrar: Consistency of Cardinal Function Interpolation (*to be read by title*).—Prof. W. H. Lang: Contributions to the Study of the Old Red Sandstone Flora of Scotland, Part VI., On *Zosterophyllum Myretonianum*, Penh., and some other Plant Remains from the Carmyllie Beds of the Lower Old Red Sandstone. Part VII. On a Specimen of Pseudosporochnus, from the Stromness Beds (*to be read by title*).—Sir Thomas Muir: The Theory of Orthogonants and Latent Roots from 1881 to 1918 (*to be read by title*).

Aristotelian Society (at University of London Club), at 8.—Dr. F. Aveling: Mental Association.

TUESDAY, June 7.

Zoological Society of London, at 5.30.—Prof. J. P. Hill: Exhibition of Lantern-slides of Echidna Embryos.—R. I. Pocock: The Gibbons of the Genus Hylobates.—Dr. C. A. Nilsson-Cantell: Some Barnacles in the British Museum (Natural History).—R. Gurney: Zoological Results of the Cambridge Expedition to the Suez Canal, 1924. Report on the Crustacea, Copepoda (Littoral and Semi-Parasitic).—P. Esben-Petersen: New Species of *Neuroptera Planipennia* in British Collections—IV.

THURSDAY, June 9.

Royal Society of Medicine (Laryngology and Otology Sections) (Summer Meeting).—Laryngological Session, at 2.30.

London Mathematical Society (at Royal Astronomical Society), at 5.—Prof. W. E. H. Berwick: Modular Invariants Expressed in Terms of Quadratic and Cubic Irrationalities.—H. Bohr: On the Limit Values of Analytic Functions.—Prof. E. H. Neville: The Logarithmic Singularity of the Quarter-period K.—Prof. J. Proudman and F. Edith Mercer: On the Theory of the Oscillations of a Rotating Mechanical System of Infinite Freedom.

British Psychological Society (Æsthetics Section) (at Royal Anthropological Institute), at 6.—Dr. E. D. Hutchinson: The Psychology of Creative Effort.

Optical Society (at Imperial College of Science and Technology), a 7.30.—Dr. T. H. Harrison: The Use of Photo-electric Cells for Pre cision Photometry of Electric Lamps.—R. Kingslake: An Experi mental Study of the Best Minimum Wave-length for Visu Achromatism.—Sushil Krishna Datta. On Brewster's Bands. Part II

FRIDAY, June 10.

Royal Society of Medicine (Laryngology and Otology Sections (Summer Meeting).—Otological Session, 10 A.M. to 12.30.—Paper on Progressive Middle-ear Deafness:—Dr. Scott Stevenson and I Horace Richards: Preliminary Study of Chronic Middle-ear Deafnes —G. J. Jenkins: Paper.—Dr. D. McKenzie: What is Progressiv Middle-ear Deafness?—Dr. A. Gray: Demonstration by Stereoscopi Transparencies of Specimens of the Temporal Bone.—Dr. D. McKenzie Posterior (Mastoid) Drainage in Acute Suppuration of the Middle Ear.– Laryngological Clinical Meeting, at 4.—Cases and Specimens b W. S. Syme, H. Kisch, T. B. Layton, and others.

Royal Astronomical Society, at 5.—B. M. Peek: Observations c Novæ, 1926–27.—Dr. H. Spencer Jones: Note on the Mass of Venu deduced from Cape Heliometer Observations.—Dr. J. K. E. Halm: On Graphical Determination of the Orbital Elements of a Spectroscopi Binary.—R. C. Johnson: Note on the Origin of Certain Radiations i Cometary Spectra.—V. A. Ambarzumian and N. A. Kostrev: Radiativ Equilibrium in Inner Layers of Stars.—P. A. Taylor: (*a*) Th Equilibrium of the Calcium Chromosphere; (*b*) The Light-Intensit of the Calcium Chromosphere.

Physical Society of London (at Imperial College of Science), at 5.– J. H. Awbery: The Latent Heat of Evaporation of Sulphur.—E Lowery: The Refraction and Dispersion of Carbon Tetrachloride.– P. K. Kichlu: Regularities in the Spectrum of Ionised Neon.– Demonstration of the Schonherr-Hessburgh Nitrogen Fixation Arc by Capt. G. J. Finch.

Philological Society (at University College), at 5.30.—C. T. Onions The New English Dictionary.

Institution of Civil Engineers, at 6.—Report of the Special Committe on Tabulating the Results of Heat Engine Trials.

Malacological Society of London (at Linnean Society), at 6.

Geologists' Association (at University College), at 7.30.—Prof. H. I Hawkins: Echinoid Illustrations of Some Problems in Evolutio (Lecture)

Oxford University Junior Scientific Club (in Department of Zoolog and Comparative Anatomy, Oxford), at 8.15.—Prof. J. Barcroft Respiratory Pigments.

Royal Institution of Great Britain, at 9.—C. L. Woolley: Th Excavations at Ur.

SATURDAY, June 11.

Royal Society of Medicine (Laryngology and Otology Section (Summer Meeting).—Otological Session (Clinical Meeting), at 10.—D G. Portmann: The Saccus Endolymphaticus and an Operation fo Draining the same for the Relief of Vertigo.—Cases and Specimens b Dr. A. R. Friel, A. R. Tweedie, Dr. T. B. Jobson, N. Barnett, E. I Barnes, and others.

PUBLIC LECTURES.

WEDNESDAY, June 8.

University College, at 5.30.—Prof. Raymond Pearl: Experiment Vital Statistics. (Succeeding Lectures on June 9 and 10.)

THURSDAY, June 9.

Institute of Pathology and Research (St. Mary's Hospital), at 5.– Prof. B. J. Collingwood: Molecular Movement in the Living Body.

FRIDAY, June 10.

University College, at 5.30.—Prof. R. A. S. Macalister: Celtic Ar (Succeeding Lectures on June 13 and 15.)

SUNDAY, June 12.

Guildhouse (Eccleston Square, S.W.), at 3.30.—Dr. R. E. M. Wheele Some of the Ancient Civilisations of Britain.

CONVENTIONS.

June 4 to 7.

Annual Conference of the Association of Teachers in Technica Institutions (at Plymouth).

June 6 to 9.

Convention of Canadian Chemists (at Quebec).

June 6 to 11.

Photographic Convention of the United Kingdom (at Warwick).

Monday, June 6.—Afternoon.—Welcome by the Mayor of Warwic Installation of President. Presidential Address. Annual Gener Meeting.
Tuesday, June 7.—Evening.—H. Baker: Lecture.
Wednesday, June 8.
Thursday, June 9.—Evening.—A. S. Newman: Lecture.
Friday, June 10.—Evening.—A. Keighley: Lecture.
Saturday, June 11.

June 16 and 17.

Congress of Internal Combustion Engines (at Padua).

SATURDAY, JUNE 11, 1927.

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Foundations of Empire.

WE regret our inability, at the present moment, to climb to philosophical heights with Aristotle and to declare that man is a political animal, or to sink into the comfortless cynicism of Schopenhauer and to assert that human society is a collection of hedgehogs driven together for the sake of warmth. Somewhere between the two exaggerations lies truth—whatever that may be. In the meantime our function, as we conceive it, is to probe, analyse, compare, and classify phenomena in the purely agnostic spirit which is the life and hope of science. This may be regarded merely as a restatement of something already grown platitudinous, yet it may appropriately serve as a prologue to some observations upon a programme of a forthcoming imperial event.

On June 20 the inaugural meeting of the third Imperial Education Conference is to be held. It will be open neither to the public nor to the press, membership being confined to delegates appointed by the Governments of the countries composing the British Empire—usually the permanent heads of their education departments—together with representatives of certain Government departments in Great Britain. For the first time in the history of the Conference, also, a few seats have been allotted to representatives of local education authorities and the teaching profession.

We are further informed that the advisory committee responsible for the arrangements, after consulting all the Governments of the Empire, "has drawn up a comprehensive agenda which covers not only important administrative questions but also a number of subjects of general educational interest." It is hoped, particularly, that some agreement may be reached on problems arising out of the variety of teachers' qualifications, salary scales, and superannuation, since these are matters where lack of reciprocal arrangements tends to hinder the movement of teachers from one part of the Empire to another. With that aspiration we are wholly in sympathy; it needs neither explanation nor argument.

When we turn to the groups of more general educational subjects which are to be discussed, however, we feel some misgivings. There is to be a very necessary reference to education in relation to the pupil's after-career, and here special interest will be attached to the views of overseas Dominions on the recent report of the Consultative Committee of the Board of Education—a report on which we have already expressed our views (NATURE, Feb. 5). There is to be an important discussion on the difficulties of rural education, while other sessions will be devoted to the cinema and wireless in education, physical training, adult education and the problems involved therein; and, most importantly, there stands out a group of subjects "dealing with important new ideas and developments" which appears to pivot about "Empire History and Geography."

Now it is after glancing at these suggested discussions that we would beg leave to submit our doubts as to whether sufficient advantage is to be taken of the tremendous possibilities afforded by the Conference. We do not propose to inquire here into all the implications of the word 'Empire,' but we do desire to record our belief that, if it is to signify a progressive and cultural unity, it must sum up the felicitous relations of component parts based upon the mutual benefits arising out of trade and industry.

To that end we believe a considerable part of the Conference should be devoted to an examination of the possibilities of pure and applied science. We make the suggestion because we observe that a special feature of the Conference is the leaving open of a whole session for the discussion of a subject to be chosen by the members during the second week. We have a special reason for urging that a broad discussion of the value—both cultural and practical—of science and technology in education is necessary in matters of Empire development. If we say that the functions of science include intercourse for the purpose of more efficient co-operation and economy of intellectual labour by the discovery of general laws governing typical situations, we shall not be placing anything on record for the first time. We shall, however, be repeating something to which controllers of education and directors of imperial destinies often give lip-service and very little more.

It is the very fact that science possesses a more international quality than matters which usually come under the heading of literature or philosophy which makes us press specially its claims to the Conference. If it be neglected, if it be treated merely as incidental, a structure of recommendations will be erected by the Conference on an unsound foundation. We have already doubted whether man is a willing political animal; we certainly doubt his ability to hold an Empire together by a repetition of academic theories.

The well-being and happiness of either a nation or an empire depend upon mutual production and exchange. Production and exchange—from raw material to the distribution of finished articles—involve change and adaptation of materia power, transport, and business organisation. A these, subdivided into the various branches c knowledge, form the subjects included in curricul of technical institutions. How far is the shapin of such curricula to be a subject of discussio by the Conference? How far, in short, is scienc (in its broadest sense) to be dealt with with th view of producing methods which shall clear awa disorders and anomalies capable of cure?

In what light, for example, will 'History' b treated? Will there be an attempt to gain fo the Empire the urge and the clarity of though which might arise from a synthesis of those event which have made British imperial developmen possible? How far have we clearly focussed th flow and direction of human endeavour arisin out of geographical discoveries of the fifteent century?—Magellan's circumnavigation of th earth, the cosmic system of Copernicus and othe liberations of the mind of the sixteenth century the founding of experimental science by Galile Gilbert, and Harvey, and the vast spread o scientific knowledge which led up, finally, in th nineteenth century to the theory of evolution—the application of which to branches of art an industry has powerfully aided the demolition o time and space, and has enabled us, with ou steamboats and our railways and our telegraph to hold together in a developing understandin the far-spread units which make up the Britis Empire? The focussing of these things would, w believe, give to the Conference an impetus toward clear and rational efforts to grasp and remove th stupid barriers which so often hold back development, and to use the great instrument of education so that it shall more swiftly build up th materials of progress.

We realise that we may have laid ourselve open to the charge of waving our own particula flag of science and technology. It is not a charg we fear, since we have our own convictions concerning the liberal and cultural powers of what i often ignorantly regarded as 'merely utilitarian. We realise, too, that we may be charged with beating the air, because all we have suggested will come within the purview of the Conference. If that be so, we shall plead guilty unblushingly. We shall freely apologise for traversing old ground even though, in making the apology, we insist that the fundamentals upon which education schemes should be built are so vital that their constant examination and repetition is not superfluous but supremely necessary.

Weather and Weather Forecasting.

Wetter und Wettervorhersage (*Synoptische Meteorologie*). Von Prof. Dr. Albert Defant. Zweite, vollständig umgearbeitete Auflage. Pp. vii + 346. (Leipzig und Wien: Franz Deuticke, 1926.) 18 gold marks.

THERE is an excellent arrangement in Austria under which from time to time one of the most promising of their meteorologists, after a period of official work in the State service, is appointed to the professorship of meteorology at Innsbruck, where he has leisure for the closer study of that branch of the subject in which he has become specially interested. This results not only in additions to our knowledge on the frontiers of the subject, but also in text-books which give in collective form and in logical sequence a summary of our knowledge over some sector of the meteorological circle. Notable examples are the "Meteorological Optics" of Perntner and the "Dynamical Meteorology" of Exner. The present officer at Innsbruck, Prof. Defant, adds as his contribution a book on weather and weather forecasting which is a development of a small book prepared and published originally in 1916–17.

The book is divided into three parts, corresponding with the author's general view of the subject. The first part, on weather, is devoted to a discussion of 'diagnosis'; the second part, on weather forecasting, indicates the methods to be followed in the 'prognosis.' The third part gives a summary of our knowledge of weather changes of longer period, a knowledge which has not yet reached the stage at which it can be applied for regular forecasts of months, seasons, or years in the European area.

In an initial chapter Prof. Defant indicates the development from weather rules and the weather prophet to the synoptic chart as the scientific basis of forecasting. He reproduces an interesting chart, due to Brandes, showing the distribution of pressure and wind in Europe on March 6, 1783, the first synoptic chart in meteorological history.

Detailed particulars are given of the revised International Code for Weather Telegraphy, but for some reason it is described as the 'Swedish' code, and Great Britain and Norway, where this code has been used since 1921 for international exchange, are represented as using different codes special to themselves. (There is an error on page 15, where the figure for alto-stratus is given as 4, which should have been allotted to alto-cumulus.) The importance of wireless telegraphy in post-War developments is emphasised, and a wireless installation is stated rightly to be now an essential complement to a weather service.

There is a remark in this chapter the importance of which cannot be too often emphasised. In forecasting, and in any examination of meteorological observations by means of maps, accidental errors of observation can often be readily detected; but there are atmospheric conditions in which individual stations may show apparently irregular differences from other stations, and there is a risk that the most interesting and instructive meteorological situations may pass without investigation, owing to the observations being regarded as erroneous and 'corrected' for the errors.

In the second chapter an account is given of the connexion between wind and pressure. In the original analysis by Guldberg and Mohn, the motion of the air near the earth's surface was assumed to be steady motion with a balance between the three forces due to the pressure gradient, the effect of the earth's rotation, and the surface friction, the last named being taken to act directly opposite to the motion. Prof. Defant, following Sandstrom, shows that a better agreement with the facts is obtained if the frictional force is assumed to act in a direction which is inclined at a finite angle (38° for central Europe) to the direction of motion.

This assumption of a single frictional force, which is essentially the vector difference between the force due to surface friction and the tangential stress due to transfer of momentum by eddies, obscures the physical reality. Actually the transfer of momentum to the surface layer from the layers above is so rapid that the tangential stress due to it is large in comparison with the forces due to the pressure gradient and the earth's rotation, even for a layer of finite thickness. The motion of the surface layer is, therefore, effectively determined by the balance between surface friction and tangential stress, acting in opposite directions *along the line of motion*. The pressure gradient and the earth's rotation do not directly affect in measurable degree the surface wind, or the wind in any layer where there is a rapid rate of change of horizontal velocity with height and the motion is turbulent; they determine completely the wind in those layers where the tangential stresses are small, *i.e.* generally in layers at heights of 1000 feet or more, and they play their part in the intermediate layers where the tangential stresses are of the same order of magnitude as themselves, layers from which the momentum to maintain the motion near the surface is transferred.

The fact that the 'mass forces' due to pressure gradient and earth's rotation can be ignored in treating the surface layers, implicit in Taylor's discussion of the subject, was stated explicitly by Whipple in 1920. No mention is made of this in the book, and there is nowhere any account of the development in our knowledge of turbulence in the last fifteen years, and its applications in all dynamical and thermodynamical studies of the atmosphere. The statement on p. 30 that but for the earth's rotation the wind would blow direct in straight lines from the places of highest pressure to those of lowest pressure needs qualification; with curved isobars there would be usually a rotatory wind system irrespective of the earth's rotation, and waterspouts and dust-devils would occur much as they do at present.

Chap. iii. deals with the motion of the air and its connexion with cloud and precipitation, and it introduces the reader to the work of Bjerknes and the idea of fronts, lines of convergence and of divergence. It is pleasant to see in this chapter reproductions of trajectories of air over the Atlantic from Shaw and Lempfert's "Life History of Surface Air Currents." The reproductions are much superior in appearance to the originals printed by the British Stationery Office. In the description of a warm front on p. 47, Ci-Cu. should be Ci.St., and it ought to be noted that in the warm sector, where normally cloud diminishes and precipitation ceases and the barometer remains nearly steady, it is not infrequent to find an overcast sky with heavy precipitation and a rapidly falling barometer. Some account could appropriately have been given in this chapter or the next of "les systèmes nuageux" and the work of Schereschewsky and Wehrlé, which constitutes the contribution of French meteorologists to the recent development in forecasting.

The discussion of the relation between the weather and typical forms of the isobars is an effort to combine the old ideas of cyclones and anticyclones and the new ideas of fronts dividing masses of air of different constitutions. Fortunately the new theories have, on the whole, gained pride of place. There is a good account of the ideas of Bjerknes and Solberg on the development of cyclones and occlusions, as well as an indication of the principal results of the important research of Bergeron and Swoboda, in which developments along a front extending from mid-Atlantic to eastern Europe in October 1923 were examine in detail and interpreted.

The fifth chapter deals with the non-periodi variations of pressure and of the motion of cyclone and anticyclones in the European area. Va Bebber's well-known diagram is reproduced, an Hanzlik's penetrating analysis of the temperatur conditions in anticyclones finds here an appropriat place. The difference between the cold rapidl moving anticyclone and the warm stationary, o slow moving, anticyclone is of fundamental im portance.

In the second part of the fifth chapter th author considers the constitution and origin c cyclones and anticyclones, and contrasts the wav theory of Bjerknes with the 'bar' theory of Exne According to Bjerknes, depressions arise fron waves at the sloping surface of separation betwee the cold polar air and the warm tropical air, an come in families, while according to Exner, de pressions arise through a tongue of cold air pro jecting horizontally into a warm equatorial curren and damming it up in such a way that vortica circulation results. Considerable space is naturall devoted to a consideration of thunderstorms an line-squalls, on which the experimental work o Schmidt on the motion of a heavy liquid spreadin under a lighter one has thrown so much light; th diagnosis is, however, quite inadequate withou some account of the thermodynamics of th phenomena and of the part which the condensatio or evaporation of water in the atmosphere plays i causing instability.

The section on cyclones and anticyclones concludes with an account of periodic variations of weather. These are not sufficiently well established to be of much value in forecasting: the most interesting is a period between five and six days which Prof. Defant found in the general circulation of the northern hemisphere; this agrees generally with the theory of Bjerknes and Solberg on families of cyclones.

The section on weather forecasting occupies only about one-fifth of the book, the author's view being that diagnosis is the most important part of the forecaster's education. After some general remarks and a short discussion of Richardson's investigation of the method of weather prediction by numerical process, the author considers the use which can be made of local observations and statistics in forecasting, and he gives an interesting account of a method of determining the delimitation of the districts into which a country must be divided for forecast purposes. He deals t some length with the rules of M. Guilbert and ith the persistence of weather conditions. He xamines in detail examples of weather charts for Iarch 13, 1913, and June 1, 1924, and indicates ow the charts are to be interpreted in the light of odern theory.

Many people appear to consider that weather orecasting is the sole purpose of meteorology; ccording to Prof. Defant, it stands in the same elation to meteorology in general as an applied cience stands to a pure science. There are eteorologists of the purer kind who consider that eather forecasting is a combination of drudgery nd humbug by means of which funds are obained for the prosecution of work fundamental o the extension of knowledge. Such a view is ased on a misconception. The desire to forecast he future course of the weather is as legitimate n impulse to the scientific investigation which s necessary for its satisfaction as the desire to nderstand or investigate any natural phenoenon. The two impulses—the desire to undertand and the desire to foretell—are in fact he motive force in scientific investigation, and either can be classed as better or worse than he other.

One of the principal difficulties of a forecast ervice is to obtain an objective test of the accuracy f forecasts. Prof. Defant indicates what progress as been made in this direction—unfortunately ittle. The subjective estimates of the accuracy r inaccuracy of weather forecasts formed by the public are of no real value, because a forecast overs a considerable number of phenomena and he public lays stress now on one and now on nother; it is, moreover, influenced, broadly speaking, by its own optimism or pessimism. Such is Prof. Defant's view, but a good forecaster must have some understanding of the needs of the public, and must himself emphasise in his forecast the elements which will affect most those for whom the forecast is issued.

Hitherto there has been no book on weather forecasting in which the post-War developments, both in the collection of information and in its analysis, have been presented in their appropriate place as part of the whole scheme of weather forecasting. The present book is notable because it makes an endeavour to do this. Information which is scattered through many international reports and through many dissertations is here available for the reader. There are errors and gaps, but on the whole the result at which Prof. Defant aimed has been achieved successfully.

E. Gold.

Land Politics and Economics.

Politics and the Land. By Cecil Dampier Whetham. Pp. x+215. (Cambridge: At the University Press, 1927.) 6*s.* net.

Mr. Dampier Whetham has chosen a most opportune time for bringing out his book upon the land. It is so clearly and interestingly written that it should appeal to a wide public, to those who know little about the land as well as to those who are directly interested in the land and in agriculture.

There is no doubt that an ever-increasing number of people in Great Britain are being stirred to an interest in the land—but mainly from the political point of view. Now a purely political interest in the land can be dangerous unless it is balanced by some understanding of economics and of agriculture. The author is specially qualified to deal with the land problem precisely on account of his knowledge of economics and of agriculture from the practical side. His moderate and carefully reasoned reply to the policies (overwhelmingly political) put forward by Mr. Lloyd George and the Labour Party is admirable. Mr. Whetham shows conclusively that to resort to such drastic change (which would certainly be in the nature of experiment) as nationalising the land is not warranted, and would be fraught with danger.

It is interesting to note in this connexion that the decidedly socialistic government of Czechoslovakia, when it brought in sweeping land reforms, did not nationalise the land, but rather developed small ownership. The reason for this was given in the words of several of the leading statesmen of the country, that State ownership or nationalisation in any form could end in one thing only—the ruin of the agricultural industry.

Perhaps of even more importance than his handling of "politics and the land" is Mr. Whetham's exposition of "economics and the land." He shows how and to what extent certain economic forces affect agricultural prosperity. In simple language he goes deeply into the economic questions which it seems obvious few of the land reformers have studied or understood—and still fewer agriculturists. Yet they are questions which every agriculturist as well as every reformer should understand.

In thus ably refuting the attacks upon the existing land system in Great Britain, I feel that Mr. Whetham gives the impression that he is more satisfied with the present system than he really is; it is quite true that he points out that the system is not perfect and could be improved, but I refer to the general impression. Mr. Whetham certainly regards the landlord-tenant system more favourably than I do. Before the great depression of the 'eighties, I concede that it was about as good a system as could be devised, but during the past forty years it has steadily become more and more unsatisfactory, especially from the landowners' point of view. It is obviously satisfactory to the tenant. Discussing this question with a frank and outspoken farmer, he summed up thus: "As long as you landowners are content to put your hands in your pockets and pay for us, pray go on doing so; when you get tired of it, see that we can purchase under sound financial conditions."

Mr. Whetham clearly does not favour the development of an increase in occupying ownership as a partial alternative to the tenancy system, and the strongest barrier against nationalisation; he fails to realise that unless occupying ownership is developed, then nationalisation of the land is inevitable. He points out that in the United States the tendency is away from ownership towards tenancy; but the farmers in the United States are, in the main, occupying owners, and the tenancy that is developing there is in no way like the British system, but rather a partnership tenancy resembling the *métayer* system in Italy and parts of France. Hand in hand with the development of occupying ownership in Great Britain might well go the creation of a system of partnership farming, but of a type very different from the *métayer*. Space does not permit me to give here a detailed account of the form of partnership farming which I advocate and have practised for nearly twenty years.

Coming to another point, the author does his best to persuade us that the yield from the corn land of Great Britain is as high or higher than any other country in Europe (except Belgium). He bases his argument largely upon the statistics of a particularly urban economist who shows that the corn yields of Denmark when 'corrected' are no higher than ours. I am interested in this 'correcting' of yields, and in future I must not believe my eyes when motoring through the Fens or Lothians, but take consolation in thinking that the very heavy corn crops one sees on every side when 'corrected' are no heavier than those of the poorer soils in my immediate neighbourhood! In general terms the corn lands of Great Britain are richer than those on the Continent, and the comparatively low average yield in France, for example, is due to the fact that the thrifty French peasant grows corn on land that we would n cultivate at all, and so the high yields of the P de Calais are pulled down.

Mr. Whetham deals admirably with the law diminishing returns, and points out that at prese prices it would not pay greatly to increase th yield of corn in England, that the extra expenditu on artificials and cultivation would only increa the loss. But it is a very different matter if considerable increase is secured not only withou greater but actually with a decreased expenditur Lucerne will grow over a wide area of land i England. My own experience is that on poor arabl land sown with lucerne which is allowed to stan for six years and then ploughed up, the increase i soil fertility is sufficient to secure for five to nin years subsequent corn crops that will average u to double the corn crop normal to that land; an this with a great reduction to the manure bil This indicates one direction in which costs o production can be reduced, and I am convince that still more can be done to reduce costs by th high organisation of the farm as a unit than i generally realised.

As regards the reverse of the medal—prices— agree with Mr. Whetham that they are a governin factor, but if the prices are low, it is even mor important that the farmer should get the potential maximum, that the spread between produce and consumer be reduced by organised marketing A highly organised industry can always withstand depression better than one that is no organised.

Finally, while I quite agree that England is much more naturally (and economically) a grass country than the Continent, there is no getting away fro the facts that much land is under grass which i not suited for grass, that the area of first-class gras land is limited, and that we have millions of acre of poorly handled grass which it would be economi to improve. I do not make these criticisms in any carping spirit, but because I believe it is of suprem importance that agriculturists in Great Britain should realise that the Government is not going t assist them to any material extent, and that it rest with the members of the industry to explore fo themselves every avenue that will lead to an improved position. I am convinced that Mr Whetham's book will prove of utmost value in thi direction. It will stimulate thought, and, above all every one who reads it will have not only a comprehensive but also a balanced view of the agricultural situation in Great Britain as it i to-day.

CHRISTOPHER TURNOR.

Time and Perception.

An Experiment with Time. By J. W. Dunne. Pp. iv + 208. (London: A. and C. Black, Ltd., 1927.) 8*s.* 6*d.* net.

> "'Tis the sunset of life gives me mystical lore,
> And coming events cast their shadows before."
>
> (CAMPBELL.)

THROUGHOUT the ages philosophers have amused themselves with time, with little to go on but their own uncertain introspections. More recently the scientific worker has found himself compelled to examine this concept critically and has exposed its interlocking characteristics with space. From the theorist to the experimentalist is a short step in science, but here a difficulty arises from the intangible nature of the material to be handled. There is no doubt that the man-in-the-street, the apparent ultimate arbiter of common sense, does not accord to time the same kind of reality as he accords to other objects in his universe. He has an uneasy feeling that it really is something purely psychological which dies with him, although he uses the same kind of terminology about it as he does about material objects. He talks of 'intervals of time,' of 'time flowing,' and so on; but if pressed he would probably agree with Bergson that only the present exists; past events have existed but do not now, although mental pictures or memories of them exist now; future events do not exist, no memories of them exist now, but pictures of them may be imagined now. The man-in-the-street may, however, be wrong. He has always been wrong, for has he not been rescued from the ignorance of the past? Relativity gave him a shock, but while relativists may contend that A's present may be B's future, so that in a sense A may remember B's future, it is not contemplated that A may remember his own future. If Mr. Dunne is correct, on waking from a dream we may, like the lady in the limerick, "return on the previous night."

There are two distinct portions to this book which ought to be dealt with separately, and the author practically does so. In the first part the startling experimental facts are described which serve as the end to which to direct an equally startling theory. The theory must wait, for it is so strange and unconvincing that the only justification for propounding and examining it would be found if the experimental facts turned out to be unimpeachable. Broadly, the theory assumes that our field of perception of events *moves* through time, and therefore its time-speed must be measured with reference to another and quite differently dimensioned 'time'; that this 'time' must likewise involve the existence of a third 'time,' and so on, giving what the author calls 'serialism' in time. Similarly our conscious perception of events, perceiving ourselves perceiving, involves the existence of a sequence of observers (ourselves) with the conscious observer at the head of the sequence, another form of serialism. On this as a basis, but apparently by an appeal to geometrical intuitions, the author seeks to show that every time-travelling field of presentation is contained within a field one dimension larger, travelling in another dimension of time, the larger field covering events which are past and future as well as present to the smaller field, and that all these are observable to the serial observer and therefore to the conscious observer at the head of the series. All that remains after that is for the author to show that the 'future' will be best observed when the mind is freed from the normal waking images, and this is what he attempts to do experimentally.

We may safely ignore the theory until the shock of the facts, if so they be, has spent itself. Whatever preconceived prejudices we may possess against what Mr. Dunne proposes to establish—and the present writer has them strongly—it must be at once admitted that the author appears to be a careful, sane experimenter quite alive to the dangers and pitfalls that may beset an observer in a strange field; and if only for the honest and straightforward manner in which he seeks traps and the precautions he takes to eliminate them, his work must be given due consideration.

For years Mr. Dunne has kept a systematic record of his dreams recorded immediately on waking, since dreams fade away so rapidly. He piles up case after case of dreams that have been followed a few days later by their counterparts in actual occurrences. Mere coincidence in one or two details he rules out. For example, to dream of a pile of coins toppling over, and to see such a catastrophe next day, would not suffice. Any bank clerk might experience that without significance, but to dream of a pile of *sixpences* toppling off a *red book* and to experience the event shortly afterwards would require examination. To take an actual illustration at random: while staying at the Hotel Scholastika in Aachensee in 1904 he dreamed he was walking along a path between two fields separated by high railings, when suddenly a horse in a field on his left appeared to go mad, tearing about, kicking and plunging in frenzied fashion. Having glanced at the railings to see that he was safe, he was continuing on his way, when suddenly the horse, which had somehow entered the path, came after him. It was a full-fledged nightmare. Like a hare he sped towards a flight of stairs at the end of the path, the horse in close chase, when he awoke. Next day, while fishing with his brother, he witnessed a drama which tallied in most of its particulars with the dream. It was his brother who directed his attention to the plunging horse. Looking up, he saw the fields—smaller than in his dream—the path, the railings (also smaller), and the flight of stairs leading to a bridge over the river. In a moment the horse had jumped the railings and was tearing down the path towards them as if demented. It swerved, avoided the stairs and plunged into the river, swam towards the fishers, clambered out of the river, snorted, and calmly trotted off.

These dreams the author claims were not impressions of distant or future events, but merely the usual commonplace dreams composed of distorted images of waking experiences, strung together in the usual half-senseless fashion peculiar to dreams. If they had happened on the nights *after* the events they would have exhibited nothing in the smallest degree unusual, but they occurred on nights *before* the events. The author claims to have convinced a number of sceptical friends who placed themselves under his guidance that such dreams occur to them also, so much so that one of them endeavoured to use it to spot a Derby winner!

If this work is not a practical joke, and it does not sound like it, and if the author is sane, and there is ample contributory evidence of this, the subject he has opened up ought to be examined so that his contentions are either substantiated or demolished. The ordinary scientific worker will not easily concede that in effect unknown future events can influence the state of the brain in the present, except indirectly in the sense that the present state of the brain and the future events may be affected by a common agency. It is quite possible, on the other hand, that certain of the confirmatory events described that mainly involved action on the part of the author may actually have been suggested by the dreams. The present writer once dreamt that he had invented an incandescent gas mantle which he in his dream called the "Elijah Mantle"! He has often since then thought of following up the suggestion. Although many of the illustrations vouched for in this book would be exceedingly difficult to explain away on these hypotheses, it would appear to be the hypotheses, if not the only ones, on which to proceed once the evidence has been thoroughly verified and sifted.

H. Levy.

Popular Biology.

Essays in Popular Science. By Prof. Julia Huxley. Pp. xii + 307 + 6 plates. (London Chatto and Windus, 1926.) 16*s.* net.

The task of the populariser is becoming mor and more difficult. If he attempts t produce something better than the superficia stuff that is served up by the popular Press, h is met with two difficulties: first, that science itsel is over-specialised, and the results achieved in eac little compartment of study are of interest onl to the very few who can appreciate them; an secondly, that the cultivated public on the whol lack the necessary mental background of scientifi knowledge and the understanding of scientifi method which would enable them to assimilat results of major or general value. But if his tas is more difficult, it is also more important, and i both directions. For not only can he exercis great influence on the general thought of th community by skilful presentation of the mature and general results of scientific research, but he ca also do great good to science itself by taking bird's-eye view of the specialists' domains an extracting from their multifarious details something of general import, some view or theory whic may not be altogether accurate, but may act a a stimulus, or even as an irritant, and lead to mor adequate synthesis. There is a close connexio in fact between popularising and generalising.

It is too often forgotten that science does no consist in the mere accumulation of knowledge that facts buried away in papers and text-book do not by themselves constitute science. There is needed in addition the spirit of synthesis an the power to fuse all the facts into a coheren system which in its turn shall link up intelligibl with some general philosophical *Anschauung* Prof. Huxley expresses this all-important poin admirably in the following passage:

> "The works of man only live in so far as ma vivifies them: and this *corpus* of fact that to some people constitutes the reality of natural science is only a vast stamp-collection, no more than lumber room, unless each generation in its tur will make it live. It lives most strongly (so i the human mind constructed) by being wove into the general background of some genera philosophy of things. The history of science shows us how a body of fact, comparatively iner and lifeless while held in one framework of opinion may be seized by another more vigorous movemen of the mind and used as a living battering-ra to beat open the doors of progress" (p. 164).

Better, on the whole, a wrong or premature synthesis than no synthesis at all. It is a curious fact that some of the most potent theories, theories that have most stimulated thought and research, have been found in the long run, after a period of vogue, to be very largely wrong. One might instance Weismann's brilliant theory of the germ-plasm, which exercised an extraordinarily powerful and lasting influence on biological thought.

The present volume of essays by Prof. Julian Huxley is a more heterogeneous collection than his previous book entitled "Essays of a Biologist," and some of the shorter articles and reviews might well have been omitted. There remain, however, many papers of real value, of interest both to the general public and, particularly in one case, to the professional biologist. Prof. Huxley's gifts as a popular exponent of biological science are undoubted; he is always lucid and interesting, and links up his themes with human life and literature in such a way as to appeal to any cultivated reader.

The first half-dozen articles deal with the problems of heredity and sex in the light of modern genetics. It seems to us that Prof. Huxley states the gene theory in too confident terms. The paper on "Chromosomes, Mendelism and Mutation" is a triumph of lucid exposition, but it will give the ordinary reader the impression that the problems of heredity are all solved. But this is far from being the case. Other articles deal with "The Control of the Life-Cycle," "The Meaning of Death," "Birth Control," "Evolution and Purpose," and there is a sympathetic and penetrating study of the author's grandfather and his attitude towards religion. Apart from a number of republished reviews, the rest of the volume is taken up by two papers, hitherto unpublished, on "The Frog and Biology" and "The Tadpole: a Study in Developmental Physiology," the latter based upon an address delivered at the British Association meeting in Liverpool. The paper on the frog gives an interesting and well-illustrated account of the action of internal secretions upon metamorphosis and colour-change; the other, some 85 pages in length, is a very valuable sketch and well merits attention from the professional biologist—it is rather too 'strong meat' for the ordinary reader. We have here a good summary and a thoughtful discussion of the modern work by Spemann, Harrison, and others, on this classical object. One is interested to see that the quite fundamental ideas of Wilhelm Roux on the importance of function are at last being given the attention they deserve.

E. S. R.

Our Bookshelf.

(1) *A View of Sierra Leone.* By F. W. H. Migeod. Pp. xii + 351 + 8 plates. (London: Kegan Paul and Co., Ltd., 1926.) 31*s.* 6*d.* net.

(2) *Sierra Leone: its History and Tradition* By Capt. F. W. Butt-Thompson. Pp. 275 + 11 plates. (London: H. F. and G. Witherby, 1926.) 15*s.* net.

(1) MR. MIGEOD has given us the results of a visit to Sierra Leone of six months' duration in 1925. His book falls into two parts: the first, a descriptive narrative dealing with the colony, its people, and something of their history; the second, an analytical account of the Mende, their physical anthropology, social organisation, secret societies, religious beliefs, games, songs, and folklore. Their language is dealt with in an appendix. Sierra Leone, being one of those parts of Africa outside the northern radius which has been longest in contact with European civilisation, presents many difficulties to the student of culture, which are by no means mitigated by the presence of the Creole and Mohammedan elements. Mr. Migeod, an anthropologist with a conscience which sets a high standard, is keenly conscious of these difficulties, and they must be held responsible for much in the first part of the book which the reader may regard as scrappy and incomplete.

(2) Mr. Migeod devotes his opening chapters to the identification of places mentioned by early geographers which, there is reasonable probability to conclude, were situated in this part of Africa. Capt. Butt-Thompson writes of an area much more restricted than that covered by Mr. Migeod. Instead of the Sierra Leone of to-day with its three 'Provinces' and thirteen 'Districts,' he deals only with the history of the colony comprised in the peninsula on which Freetown stands. Nor is he concerned with the chronicles of the earliest voyagers. His history begins in the sixteenth century with the movements of peoples down to the river and the conquests of the Temne kings, which are recorded in or may be deduced from the reports of Ogilby, Fletcher, and others.

Capt. Butt-Thompson writes with a wealth of detail, and much of his material, gathered by members of his own family, has not previously been published. Much is derived from oral tradition. Travellers, colonists, missionaries, and administrators are all passed under review, and their achievements, both good and bad, recorded with commendable impartiality. Capt. Butt-Thompson's book will serve as a valuable guide to those who wish to understand the conditions out of which have grown the many and serious problems with which the administration is confronted to-day.

The Analysis of Pigments, Paints, and Varnishes. (Oil and Colour Chemistry Monographs.) By Dr. J. J. Fox and T. H. Bowles. Pp. 179. (London: Ernest Benn, Ltd., 1927.) 16*s.* net.

THIS is a book which can be heartily recommended to all who are concerned with the chemical examination of the materials in question. It is, in fact, in many respects the best of all those dealing with the subject. The first 124 pages deal with the analysis of pigments, white, red, blue, yellow and brown, green and black; then follow two chapters dealing respectively with the analysis of mixed paints and with the examination of varnishes. Three appendices dealing with (*a*) specimen analyses, (*b*) a method for the determination of tung oil in paints and varnishes, and (*c*) distempers, together with index of subjects and index of names, complete the work.

Each subject is treated in a comprehensive manner and the methods given or recommended are those which the authors, in the course of their large and varied experience, have found to be trustworthy. They are especially useful in the case of some of the rarer pigments, which are so frequently in analytical works either ignored or dismissed by a reference to "the usual methods of analysis" that, when applied, are so often found to fail. Full analytical details are always given, a course which should always be followed in analytical methods of this description. A large number of references appear at the end of each chapter, enabling any analyst who wishes to do so to consult the original papers. It is gratifying to note that the authors have made use of the specifications of the British Engineering Standards Association, to the committees of which they have given so much valuable advice. In view of the tendency to give viscosities in C.G.S. units, the authors have rightly included instructions as to how this can be done (pp. 144-150), and it is to be hoped that with this lucid description now available, those concerned with the examination of varnishes will record the viscosities of the varnishes in C.G.S. units and not, as has been so frequently the case in the past, in arbitrary units which mean little or nothing to any one other than the observer. The only small criticism we have to offer is that the symbol *p*H might have been briefly explained (p. 163), as we know from experience that there are still a number of paint and varnish 'chemists' who are not conversant with its real meaning.

In conclusion, we have no hesitation in saying that this book should be in the possession of every pigment, paint, or varnish works' laboratory.

G. R.

Constitution et évolution de l'univers. Par A. Véronnet. (Encyclopédie scientifique: Bibliothèque d'astronomie et de physique céleste.) Pp. 475. (Paris: Gaston Doin et Cie, 1927.) 28 francs.

In the larger problems of astronomy it is not to be expected, or indeed to be desired, that there should be universal agreement. The subject of this book, as indicated by the title, is the ultimate problem of all astronomical and physical research, and a final pronouncement at the present time is obviously out of the question. Cosmogony, in fact, has only just emerged from the field of unalloyed speculation, and the tentative hypotheses which can now be put forward are more of the nature of convenient summaries of known facts and indications of new directions of observation than aspirants to the dignity of absolute truth. In the volume before us, M. Verronet, following lines of thought previously laid out by Henri Poincaré considers the problem of the past, present, and future constitution of the individual bodies in the universe and of the universe as a whole. He reaches some very definite conclusions, which differ considerably from the more familiar views which we associate chiefly with the names of Eddington, Jeans, and Russell. For example, he maintains that the interior of a star is homogeneous, and has a sensibly uniform temperature about double or triple the surface temperature. Needless to say, he rejects Eddington's theory of radiative equilibrium, which he regards as being mathematically impossible. The age of the sun is placed at a few million years, and the past history of the universe is held to be almost negligible in duration compared with the future. These views are sufficiently unfamiliar to attract attention, and since M. Verronet gives reasons for the conclusions at which he has arrived, his work demands respectful consideration. It will doubtless not meet with general acceptance, but may nevertheless have some part to play in the advancement of knowledge.

Cours de physique à l'usage des élèves de l'enseignement supérieur et des ingénieurs. Par Prof. Jean Becquerel. Tome 2: *Élasticité. Acoustique.* Pp. ii + 427. (Paris: J. Hermann, 1926.) 6s.

The second volume of Prof. Becquerel's treatise on physics contains sections on elasticity and sound, the former subject occupying about one-quarter of the available space. The first chapter deals with the physical study of elasticity and the determination of the elastic constants; the second treats of the mathematical theory of elasticity. On the experimental side particular attention is given to the researches of Wertheim and of Amagat; on the theoretical side the aim has been to emphasise only essential questions and to derive the formulæ necessary for the propagation of waves in a homogeneous, isotropic medium. This discussion paves the way for the treatment of wave propagation in the next chapter, which deserves special mention for lucidity of treatment. In fact, throughout the volume the author gives an exceptionally clear exposition of what may be termed the classical theory of acoustics. Stress is laid for the most part on the mathematical rather than on the experimental aspects of the subject, but there is a valuable chapter dealing with the applications of acoustics in music which is unusually complete for a book of this character.

On account of the greater novelty of the subject matter and of the methods employed, the last three chapters in the book are, perhaps, the most interesting. The first of these deals with noises heard in the air, underground, and under water; instruments are described, many of them devised for use by the French army during the War, for determining the direction of the source of sound, and the subject of range-finding is given a chapter o itself. Finally, we have a short but suggestive hapter on the acoustics of halls, containing an ccount of the experiments of Sabine and of larage.

he Preparation and Analysis of Organic Compounds. By J. Bernard Coleman and Dr. Francis Arnall. Pp. xvi+352. (London: J. and A. Churchill, 1926.) 15*s.* net.

HE task of an author in compiling a text-book of ractical organic chemistry is by no means an easy ne, on account of the difficulty in framing a ystematic scheme of qualitative organic analysis. he present authors, however, have made a very uccessful attempt to give a rational scheme of nalysis of unknown organic substances and ixtures.

About a third of the book is devoted to a ystematic description of the methods of syntheising the important members of the main groups f organic substances, the reactions, preparation, nd properties of which are described, together with otes on precautions necessary to be observed. This orms a striking feature of the book, as the complete xperimental detail for the preparation of eighty-ine representative bodies is associated with an xplanation of the theoretical processes involved.

The next portion deals with the qualitative nalysis and identification of organic compounds, nd this, equally with the preceding section, has een carefully devised and should prove of great alue to students. The systematic manner in which the properties of different types of organic ubstances are displayed appears to the reviewer to be specially valuable, although from his personal xperience a few of the physiological tests, such as those depending upon smell, are not in accordance with his own observation.

Finally, there is an excellent portion dealing with methods of ultimate analysis and estimation of typical groups.

This book can be confidently recommended to students of organic chemistry. L. C. N.

The Amarna Age: a Study of the Crisis of the Ancient World. By the Rev. James Baikie. Pp. xix+465+32 plates. (London: A. and C. Black, Ltd., 1926.) 12*s.* 6*d.* net.

WHEN the discovery of the tomb of Tutankhamen was made the occasion of a newspaper 'stunt,' some misgiving was felt whether such wide publicity was likely to be a real benefit to archæology in the long run. In that particular instance it probably was not; but it had the advantage that it made the general public to a certain extent familiar with a very important period in Egyptian history. Indeed, as Mr. Stanley Cook says in his preface to Mr. Baikie's excellent account of the Amarna age, it was one of the great crises in the ancient world. Mr. Baikie's book has been written for those whose interest in this period has been aroused by the discovery of the tomb, and it is for such that he has been anxious, incidentally, to fit that discovery into its true perspective by placing it side by side with the less sensational but far more important discovery of the Tel-el-Amarna tablets to which we owe our detailed knowledge of the history of this period and from which he quotes freely.

The greater part of Mr. Baikie's book is concerned with the political, military, and diplomatic history of the expansion and decline of the Egyptian empire, but naturally the character and religious reform of Akhenaten occupy a prominent position. Mr. Baikie discusses the origin of the Aton worship, but, while he acknowledges the existence of a strong Mitanni element in Egypt, he is not inclined to admit Asiatic influence in either its universality or its monotheistic tendency.

A Guide to the Orchids of Sikkim: being a Guide to the Identification of those Species of Orchids found between the Terai and the Northern Frontier of Independent Sikkim, including the Chumbi Valley and British Bhutan. By Prof. Paul Brühl. Pp. xvi+208. (Calcutta and Simla: Thacker, Spink and Co., 1926.) 5 rupees.

THIS little book will be warmly welcomed by lovers of the flora of the Darjeeling district. The text takes the form of a key, first to the genera and then to the species, the alternatives on the whole being well chosen and distinctly expressed. Unfortunately the technical finish of the book is not so satisfactory, there being a number of misspellings of generic names, while the taxonomy is not always in line with present-day conceptions; for example, *Tainia hookeriana* has been referred to Ascotainia for about twenty years, while *Cypripedium venustum* has not been included by botanists in that genus since 1898. At the same time a book of this nature seems scarcely the most suitable place for the publication of a new genus (Cleisocentron). Nevertheless, Prof. Brühl may be congratulated on having produced a useful guide to Sikkim orchids. V. S. S.

Lehrbuch der Elektrodynamik. Von Prof. Dr. J. Frenkel. Erster Band: *Allgemeine Mechanik der Elektrizität.* Pp. x+365. (Berlin: Julius Springer, 1926.) 28·50 gold marks.

As the title implies, this is an attempt to treat electromagnetic theory as a branch of general mechanics. The fundamental unit is not the charged particle, the existence of which depends upon the existence of the corresponding opposite charge, but the electric doublet or dipole, the moment of which vanishes in a neutral particle. This makes it possible to deal with vector quantities, instead of the scalar quantities represented by 'charges.' Vector algebra is therefore liberally employed, and the author devotes 36 pages to a consideration of its principal operations. It becomes necessary to regard electrons as geometrical points, or rather as point singularities in the space-time continuum. The author, as is natural in the atmosphere of Leningrad, seeks to break with the historical development of electricity, and as a first step discards the conception of the ether, which he regards as obsolete. It is an interesting attempt, but whether it will be fruitful is another matter. E. E. F. D'A.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Pinholes in Photographic Negatives.

PINHOLES are a serious problem in the case of some photographs. For example, a number of pinholes in a delicate cloud photograph will quite spoil the effect, unless they are carefully spotted out. Spotting out may be easy for a professional, but the ordinary amateur finds a considerable difficulty in doing it properly, and if lantern slides are to be made the technique is still more difficult.

The common cause of pinholes is that small particles get on the face of the plate and during exposure they cause shadows, which on the resulting negative appear as clear patches. Particles may get on to the plate at various stages of its history, but the plate makers never, or scarcely ever, admit that any particles can be on the plates before they are taken out of their wrappings. My own experience, however, is against this supposition. My procedure, up to quite recently, has always been the same; I have dusted out the dark slides, opened the packets of plates very carefully, and very carefully put the plates into the dark slides; but pinholes sometimes occur and sometimes do not, and the occurrence or non-occurrence of pinholes coincides with the use of a new box of plates. With all the plates from one box I may get many pinholes, with all the plates from another I get very few; the inference is that the particles that cause them are on the plates as they come from the makers. Moreover, I have opened plates in the light and have found minute particles on their faces. Quite recently I have heard indirectly from a leading firm of plate makers that it is almost impossible to prevent small fragments of glass from the cut edges of the plates from getting on to the sensitised surface; this agrees with my experience that the pinholes are worse round the edges of a plate than near the centre. The above observations were made on plates that had not been carried about in a dark slide. Of course, if this is done, pinholes must be expected even on plates which were the most immaculate when they left the maker.

Since apparently plates can, and do, leave the makers with foreign particles on their faces, it would appear to be necessary to remove the particles before the plate is put into the dark slide. Thirty years ago or so the amateur used to be told to dust his plates; more recently, however, he has been told on no account to do this; it has also been stated, and often repeated, that dusting plates electrifies them and causes small particles to be attracted. No one who has so written can have tried the experiment; at ordinary room temperature and humidity I find that it is not possible to electrify a plate even by a very vigorous rubbing of the coated side. When, however, the plates are made very hot, and therefore dry, they can be electrified by fairly moderate rubbing; if, however, they are left for half an hour or so, they are found to have returned to their original condition. Backed plates are still more difficult to electrify by rubbing, though different makes differ in this respect; some backed Ilford Special Rapid Panchromatic and Wellington Spectrum plates showed no electrification when rubbed vigorously, even when heated to such a temperature that they could scarcely be touched by the hand; some backed Imperial Panchromatic plates, however, were easily electrified by rubbing, when made very hot. The Ilford an Wellington plates could be electrified by rubbing i the backing was removed and if they were heated Thus in the ordinary way, at room temperatures there is no danger of electrification even if the plate are rubbed quite vigorously. I now wipe the sensitised surface of the plate with a pad of velvet, an have found a very considerable diminution of pinholes as a consequence; a single sweep of the velve across the plate is sufficient.

Probably a professional finds little difficulty i spotting out pinholes, but, as I have said, the amateu finds a good deal of difficulty. When using water colour, for example, if there is too much colour o the brush, or if it is too watery, the colour leaves th pinhole and collects in a circle round it, thereb aggravating the evil; if one uses the brush ver nearly dry it entails taking fresh colour for nearl every pinhole, and the process becomes very laboriou I have lately, however, taken to using ink supplie by the Cambridge Instrument Co. for their recordin apparatus; this ink consists of colouring matter dissolved in nearly equal proportions of glycerine an water with a small admixture of gum arabic. Th used with a fine brush makes the best medium I kno of for spotting out pinholes; it takes longer to dr than, say, water-colour, but this disadvantage is fa outweighed by its ease of application.

C. J. P. CAVE.

Stoner Hill,
Petersfield, Hants, May 25.

The Polymorphism of Higher Fatty Acids.

IN continuation of former work, I have extende the study of the polymorphism of such substance (Piper, Malkin, and Austin, *Jour. Chem. Soc.*, 1926 2310; J. Thibaud, *Comptes-rendus*, **184**, 24 and 96 1927; de Boer, NATURE, Jan. 8, 1927) to the eve and odd series of saturated acids of higher molecula weight. Thin films are prepared on a glass sli either by melting or by evaporating from a solutio in ether, or better in carbon disulphide, and examine with respect to the *Kα* rays of copper by the turnin crystal method. The result is as follows: the lon spacing measured for an evaporated film differs fro that obtained from a melted acid, the latter bein smaller than the former. This property is quit general: for every acid which contains more tha 16 carbon atoms in the molecule, the magnitude o the long spacing depends on its manner of preparatio and the two kinds thus possible both seem very durable. For stearic acid I have been able to obtain upon one and the same evaporated film, two coexisten crystalline modifications.

The following table summarises the data obtaine with the even and odd series of saturated acids:

Acid.		Spacing (Å U.) of the Modification.	
		Evaporated.	Melted.
Myristic . .	$C_{14}H_{28}O_2$	31·2	31·2
Palmitic . .	$C_{16}H_{32}O_2$	38·8	35·4
Daturic . .	$C_{17}H_{34}O_2$	43·2	41·4
Stearic . .	$C_{18}H_{36}O_2$	43·95	39·9
Arachidic . .	$C_{24}H_{48}O_2$?	59 0	53·4
Cerotic . .	$C_{27}H_{54}O_2$	69·0	64·2
Melissic . .	$C_{31}H_{62}O_2$	80·4	73·5
Lacceroic . .	$C_{32}H_{64}O_2$	82·0	73
Sebacic . .	$C_{10}H_{18}O_4$	11·4	11·4

In the accompanying diagram (Fig. 1) the observed spacings are plotted against the number of carbon atoms of the corresponding acid. Piper's values and my data are complementary. The diagram shows that, for every modification, the spacings lie upon nearly straight lines (even acids show a small increase in their lines with increasing molecular weight) and it is necessary to consider a bundle of straight lines for the even acids and another for the odd ones. The lines of the "evaporated" B-modification lie above those of the "melted" C-modification. The increase of the chain's length per C-atom is respectively 1·327 and 1·146 Å.U. for the B- and C-kinds of odd acids, and 1·21 and 1·10 Å.U. for the B- and C- kinds of even acids.

It is to be noted that arachidic acid, which was examined in several samples, exhibits for these two B- and C-modifications, numbers well placed upon the even-acid diagram for 24 C-atoms, in good agreement with Piper's data for lignoceric acid. Therefore I ascribe 24 atoms to arachidic acid.

By comparison an attempt to show the polymorphic properties of a dicarboxylic acid ($C_{10}H_{18}O_4$) was unsuccessful. Afterwards, having a crystal of stearic acid, which was comparatively large and showed the long spacing (44 Å.U.) of a B-modification, I investigated the distribution of the scattering matter in this chain from a study of the higher orders of reflection (Müller and Shearer, Prins and Coster) from the long spacing, by means of the $K\alpha$ copper and molybdenum rays. The spectrum (Fig. 2) shows first, that the odd orders are much stronger than the even; then, from the 10th order onwards the even orders are the stronger, their intensities increasing regularly to a maximum at the 20th order, afterwards decreasing abruptly. Later maxima occur at the 38th and more strongly at the 40th order. With a melted stearic film (C-modification) a maximum occurs at the 18th-20th order. Then the distribution of matter in a chain of a B-modification is similar to that of a C-modification, but it shows a small discrepancy in the situation of the terminal CO_2H groups.

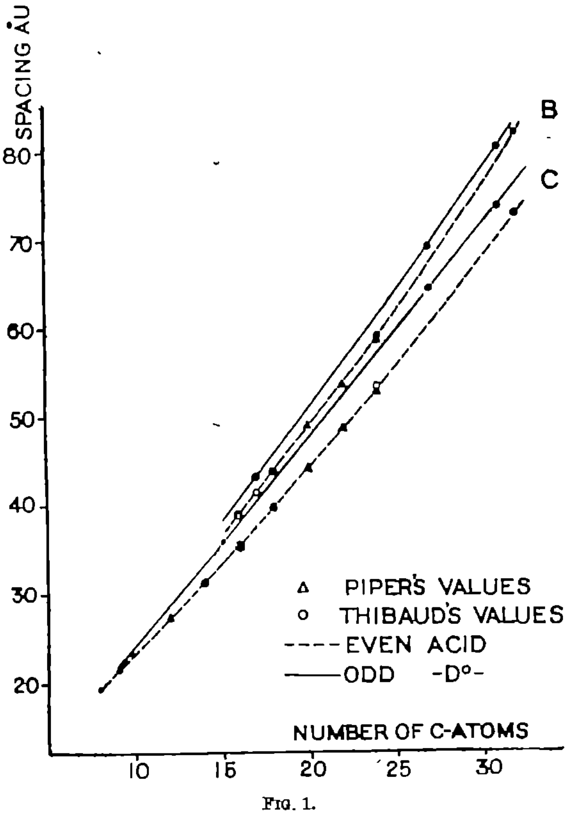

FIG. 1.

In addition to the long spacings there is a number of small ones which afford information concerning the structure of the CH_2-chain. For all acids mentioned in the preceding table and for micro-crystalline films showing the B- as well as the C-modification, I have registered the rays from these small spacings by means of the turning crystal or by Debye and Scherrer's ring method. The small spacings appear unchanged in magnitude as well as in relative intensities whatever may be the purity or crystalline variety of the acid investigated. It follows that for every saturated acid the arrangement of the C-atoms in the chain is precisely the same and is in agreement with data of a beautiful work of Müller (*Proc. Roy. Soc.*, April 1927, p. 542) upon stearic acid.

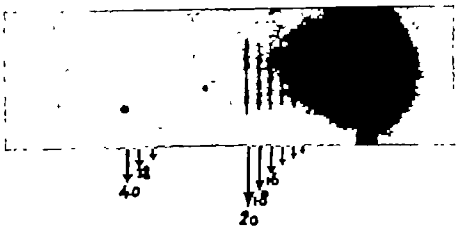

FIG. 2.—Stearic acid (Mo $K\alpha$).

I have to thank Mr. de Broglie for advice during this work.

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Quantum Theory and Gravitational Relativity.

WE wish to announce a result which indicates an inner unity between the quantum theory and gravitational relativity. The connecting link is the wave theory of Schrödinger.

Einstein's gravitational relativity is an invariantive treatment of particle dynamics, with respect to transformations of co-ordinates. Hence the notions of clocks, yardsticks, moving observers, etc., which he introduces to make his theory plausible, belong primarily to the classical kinematics of particles. On the other hand, Schrödinger makes his fundamental physical phenomenon a wave phenomenon: that is, a phenomenon expressed by a linear hyperbolic differential equation of the second order in four variables. It is thus not unnatural to seek for the real meaning of the Schrodinger theory in an invariantive investigation, not of a quadratic form, as in Einstein's theory, but of a differential equation:

$$\sum_{\lambda,\mu}^{1,\ldots,4} g^{\lambda\mu}\frac{\partial^2\psi}{\partial x^\lambda \partial x^\mu} + \sum_{\lambda}^{1,\ldots,4} g^{\lambda}\frac{\partial\psi}{\partial x^\lambda} + g_0\psi = 0, \quad g^{-1} = \mathrm{Det}|g^{\lambda\mu}| \neq 0.$$

Cotton (*Annales scient. de l'école normale supérieure*, 3^e sér. 17, 211-244; 1900; comp. also T. Levi-Cività, *Atti R. Istituto Veneto*, 8^a ser. 15, parte 2, 1331-1357; 1913) has shown that this equation can be written in the form

$$\Box\psi - 2\sum_{\lambda}^{1,\ldots,4} p^{\lambda}\frac{\partial\psi}{\partial x^\lambda} + \left(-D + F - H(x^1, x^2, x^3, x^4)\right)\psi = 0,$$

where $g^{\lambda\mu}$ is a contravariant tensor, p^ν a contravariant vector, and

$$\square\psi=\frac{1}{\sqrt{g}}\sum_{\alpha,\beta}^{1,\ldots,4}\frac{\partial}{\partial x_\alpha}\sqrt{g}\,g^{\alpha\beta}\frac{\partial\psi}{\partial x^\beta},\quad D=\frac{1}{\sqrt{g}}\sum_{\alpha}^{1,\ldots,4}\frac{\partial}{\partial x^\alpha}\sqrt{g}\,p^\alpha,$$

$$F=\sum_{\alpha,\beta}^{1,\ldots,4}g_{\alpha\beta}\,p^\alpha p^\beta,\quad H=D-F+g_0.$$

As Cotton points out, if we suppose that

$$\mathrm{K}-6\mathrm{H}=\text{Constant}=6C,$$

K being the curvature scalar of the $g_{\lambda\mu}$, the $g_{\lambda\mu}$'s and the p^ν's are in general determined in one and only one way. If we identify the $g_{\lambda\mu}$'s with those of Einstein, and assume his equations

$$\mathrm{K}_{\lambda\mu}=0,$$

where $\mathrm{K}_{\lambda\mu}$ is the contracted curvature tensor, it follows that $\mathrm{K}=0$, and $\mathrm{H}=-C$. If we take for our constant of normalisation:

$$C=\frac{4\pi^2m^2c^2}{h^2},$$

where m is the rest mass of the electron, c the velocity of light, and h the Planck constant, our wave equation assumes the form of the relativistic Schrödinger equation as given by De Donder in *Bull. Classe des Sciences, Acad. Royale de Belgique*, séances du 5 février et du 5 mars, 1927. Thus the quantisation of the Schrödinger equation is determined by the Einstein equations.

The vector p_ν, apart from a constant factor, determines the electromagnetic vector potential. The Maxwell auxiliary equation, as De Donder points out, is $D=0$. This can be satisfied without affecting our previous considerations if we change our dependent variable ψ by multiplying it by an appropriate factor of calibration.

To sum up, if we define our gravitational field in the proper invariantive manner in terms of a wave equation, the quantisation of this equation follows from the gravitational field equations. The equation also defines an electromagnetic potential, to which most of Weyl's considerations apply.

A detailed discussion of the present theory will appear in a near number of the *Journal of Mathematics and Physics of the Massachusetts Institute of Technology*.

NORBERT WIENER.
D. J. STRUIK.

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Massachusetts Institute of Technology,
Cambridge, Mass., U.S.A.,
April 2.

We can make our fundamental equation homogeneous in order by the substitution $u=\psi e^{x_5}$. We then obtain a treatment of our theory analogous to that of O. Klein, *Zeitschr. f. Physik*, **37**, 895-906; 1926: The fifth dimension turns out to be a mere mathematical convention that can be compared to the introduction of homogeneous co-ordinates in other parts of mathematics.

May 10.

Structure of Pearls.

IN a recent paper by Dr. Orton and myself (*Jour. Marine Biol. Assoc.*, vol. 14, No. 4, in the press) it has been pointed out that a thin, brown horny layer occurs in the form of a skin on the *inner* surface of the shell of oysters (*Ostrea edulis*), and is especially well developed in those from the Fal Estuary beds, in addition to the four normal strata found in the shells of lamellibranchs. This layer was found to peel off in specimens collected in the autumn of 1926, thus indicating that it was secreted at the end of the autumn period of growth. Layers of similar material have been found by us in sections of oyster shells (*O. edulis*) and by Römer in the shell of Margaritana (*Zeitschrift fur wissensch. Zoologie*, 1903, 437, Taf. XXXI., Fig. 14), alternating with layers of nacreous material. It is well known from the work of Herdman and Jameson that the structure of pearls from *Margaritifera vulgaris* is intimately related to the structure of the shell, and that new shell growth and pearl growth are probably comparable phenomena. It is also known that layers of brown material similar to that found in shells are also found in some pearls. The occurrence of a layer of brown horny material on or in the shells of *O. edulis* indicated, therefore, that similar layers might be found in the pearls taken from *O. edulis*.

In order to determine the structure of pearls from *O. edulis*, ten dry specimens were decalcified in about 20 per cent. hydrochloric acid. Some time after the pearls were immersed in the decalcifying fluid, it was noticed that two still remained at the bottom of the fluid, whereas the remaining eight were floating, due to bubbles of carbon dioxide becoming entangled in the meshwork of the organic matter left after the calcium carbonate had been dissolved from the calcareous layers. The two specimens that did not float were the only ones that were brown in colour, while the remainder were of nacreous lustre. All the specimens were dehydrated, cleared, and sectioned by the usual method. The eight 'white' pearls showed rings of organic matrix (conchyolin) with discontinuous layers of brown horny material, and with an inorganic nucleus. The two 'brown' pearls could not be sectioned completely, but a few sections (8μ thick) of the outer horny layer were obtained. On microscopic examination these sections showed a brown matrix in which rhombic crystals were embedded, and could not be stained with water-blue. In properties and structure, the outer layer of the above-mentioned 'brown' pearls resembles the brown horny layer found on the inner surface of the shell of *O. edulis*.

Three other pearls from *O. edulis*, which had normal lustre, obtained in October 1926 from Yealm oysters, were mounted dry; after a few days, the outer coating of one broke off, exposing a brown horny layer similar to the one described above. It would appear that this brown horny layer is more related to periostracum on account of its horny nature and unstainable properties than to the organic matrix of the prismatic or nacreous layers. It is also probable that this brown layer is homologous to the 'conchyolin' layer found in the shell of Margaritana by Römer (*loc. cit.*) and to the 'amorphous substance' found in pearls from *Margaritifera vulgaris* by Jameson (*Proc. Zoo. Soc.*, 1912, Pl. XLII., Fig. 41).

Herdman (Report to the Government of Ceylon on the Pearl Oyster Fisheries of the Gulf of Mannar, Parts I.-V., 1903–6) classifies true pearls into (*a*) cyst pearls and (*b*) muscle pearls. When pearls are found in the edge of the mantle they are brown, because they are composed of periostracum, which is the normal secretion of the edge of the mantle. When pearls occur in the region of the muscle attachment they possess a lustre due to their hypostracal composition, which is the normal product of that region. When pearls are formed in the mantle or in the epithelium of the visceral mass, they possess a lustre due to the nacreous secretion, which is the normal product of those regions. From the above statements it is clear that brown pearls would appear in the region of the visceral mass, or of the mantle, only when the normal rhythmic secretion is disturbed.

Jameson (*loc. cit.*) states that "it would appear that the lime salts and the albuminous fluid which ardens to form the conchyolin are independent of ach other and may be secreted in varying proportions." Under favourable conditions the secretions f the shell-secreting epidermis are so regulated that nacreous layers are formed. It is possible that under unfavourable conditions, such as a fall in temperature r the want of lime in the food of the animal, only he horny layer is secreted. It is therefore suggested hat the brown horny layers found in the pearls of O. *edulis* and on the inner surface of the shell of *O. dulis* are identical.

The occurrence of concentric layers of horny peri-stracum-like substance in pearls generally and in the hells of oysters and other molluscs may therefore be due to a disturbance in the rhythmic action of the ecreting epithelia whereby only the first part of a phase of shell-formation is completed with the on-oming of winter or at the end of a shell-growing period.
C. Amirthalingam.

Marine Biological Laboratory,
Plymouth, May 14.

The Absence of a Cellulase in Limnoria.

Owing to the almost invariable presence of fragments of wood in the stomach and gut of the wood-boring isopod, *Limnoria lignorum*, it has been assumed hat this animal is capable of digesting cellulose. Thus Calman (Brit. Mus. (N.H.) Economic Series No. 10) states: "*Limnoria* certainly swallows, and probably digests, the wood which it gnaws away to form its burrow, but it is not known whether it has any other source of nourishment." In a report on he Marine Piling Investigation, published in the Bulletin of the American Railway Engineering Association (vol. 28, No. 290, Oct. 1926), the definite statement is made that "the main food of the *imnoria* is the wood into which it bores." No experiments on the digestive powers of Limnoria appear to have been made, and it is never advisable to draw definite conclusions as to the food of any animal from the contents of its stomach, for a great deal of material may be passed through the gut which cannot be acted upon by the digestive enzymes. Though it is known hat wood is ingested intracellularly by Teredo which, as shown by Harington (*Biochem. Jour.*, vol. 15, p. 736) and Dore and Miller (*Univ. Calif. Publ. Zool.*, vol. 22, p. 383), possesses a cellulase, it by no means follows that a similar enzyme is present in the crustacean, Limnoria, in which both the alimentary system and mode of digestion are totally different.

In the hope of discovering whether wood can be digested by Limnoria, I carried out a series of experiments during a period of work on behalf of the Sea Action Committee of the Institution of Civil Engineers. Great numbers of Limnoria were collected by placing infected wood in sea water containing 20 per cent. of alcohol, as a result of which the animals came out of their burrows in great numbers and were collected from the bottom of the vessel. They were carefully isolated from other organisms, dried on filter papers and weighed. In the first experiment 2·6 grams of Limnoria (*i.e.* very many hundreds) were collected, and in the second 0·63 grams. They were then ground up with sand and an extract made in toluol water. The action of this extract was tested on saw-dust, the digests being incubated at 32° C. for two weeks in the first experiment and for four weeks in the second. Control experiments were carried out with the boiled extract, while in the first experiment the action on starch was also tested. *No indication of any digestion of the cellulose* in wood was found in either experiment, although the starch was quickly digested, the presence of glucose being indicated by means of Benedict's solution.

It appears, therefore, that Limnoria does not possess an enzyme capable of attacking cellulose. Such enzymes are rare in the animal kingdom, as I have pointed out elsewhere (*Science Progress*, vol. 20, p. 242) in a résumé of the literature on the subject. There is, moreover, no evidence of the presence of protozoan symbionts in the stomach of Limnoria, such as are invariably present in the gut of the wood-boring Termites, which enable these insects to extract nourishment from the wood (Cleveland, *Biol. Bull.*, vol. 46, p. 177, and subsequent papers). There remains the possibility of bacterial digestion, but, owing to the difficulty of obtaining sufficient material from the minute stomachs, no experiments were carried out.

Examinations of the stomach contents revealed the presence of a certain quantity of microscopic plants and animals such as diatoms, peridinians, etc., and no doubt more would have been identified but for the trituration of the gastric mill and the action of digestive enzymes in the stomach. There is a large micro fauna and flora on the wood which may quite easily supply the needs of the animals. It would appear at first sight as though this would not be easily obtained in the burrows, but, as recorded by Calman (*l.c.*), Limnoria has been found boring in the insulating covering of a submarine cable in the Mediterranean, so that it obviously can feed in this manner, since it is in the highest degree unlikely that it can digest the substance of the cable! Teredo is never found burrowing in anything but wood (though the giant Teredo apparently spends at least the latter part of its life encased in its calcareous tube buried in the sand), but Xylophaga—an allied genus resembling Teredo in its burrowing apparatus but *not* in the modifications of the gut which enable it to digest wood—has also been found burrowing into the covering of cables.

The amphipod borer, *Chelura terebrans*, resembles Limnoria in all respects. Experiments revealed the absence of a cellulase, there are no symbionts, the stomach contents are similar to those of Limnoria, and it has been found boring into the covering of cables.

There appears, therefore, to be every indication that Limnoria and Chelura bore into wood solely for *protection* and that, though they possess adaptations which fit them for boring, they are not so highly adapted as the Teredinidae, which are alone amongst wood borers—either molluscan or crustacean—in their capacity for actually feeding on the wood into which they bore.
C. M. Yonge.

Marine Biological Laboratory,
Plymouth, May 9.

Nomenclature of the Vertebrate Gut.

It is, of course, well known to all zoologists that certain names have been applied to structures in different animals without due regard to the real significance either of the name or of the structure, with the result that by now these names have lost their definiteness and with it their scientific utility. This is particularly the case of certain terms used to designate parts of the vertebrate alimentary canal, and this letter is to ask for criticism upon the following attempt to clear up at least part of the matter. Excluding many names which still have a sufficiently accurate meaning for all practical purposes (although they vary widely in significance, as some are simply topographical, others presume a similarity of function, while others again imply a true homology), I want to focus attention upon the terms 'œsophagus,' 'stomach,' 'small and large intestine,' and 'rectum.'

It is obvious that 'stomach' should only be applied to that part of the canal, whatever its shape, where the typical simple tubular (gastric) glands are present. In it should be included the pylorus, the part, long or short, characterised by the great development of the circular muscle layer; but œsophagus should be strictly segregated. If 'stomach' only means, as seems usual at present, an expanded part of the canal in this region, we need a term to apply to the region when it is not expanded and, in addition, we have to talk about part of a 'stomach' being a 'true stomach' and about 'stomachs' being partly œsophageal. After all, there should at least be one name for each functionally distinct part, unless two or more of such parts are always found in combination, and here we are actually one short. So this is the solution I propose: Stomach to be as defined above, œsophagus to be the part between the pharynx and the stomach, crop or ingluvies to be an expansion of the œsophagus, and a new term, œsogaster, to be applied to an expansion of the posterior part of the œsophagus combined with the stomach: this œsogaster may be simple, like that of the Polypterini, or complex like that of the Ruminantia. By this means all the names would, I believe, have a really useful application.

Let us now consider the other three names. The differentiation of the intestine into 'small' and 'large' took place at the time when so many other fundamental changes occurred in the anatomy of the vertebrata, *i.e.* when they took to life on land. It was as necessary to develop a 'large intestine' as to substitute a pulmonary for a branchial method of respiration, because the conservation of water became an essential item in the economy of the individual. So the intestine lengthened, a hinder portion lost its digestive function so as to specialise in absorption, and the differentiation of the 'large' and 'small' intestine was thus brought about. In the higher forms these two parts have elongated and undergone further differentiation, so that more names have been found useful, but these should not be applied to parts of the lower forms. 'Rectum' (the name applied to that last portion of the large intestine concerned with the preparation of the intestinal contents for defæcation) should therefore not be used as a synonym for 'large intestine,' and the latter name should not be applied to the post-valvate portion of the intestine of fish.

G. Leslie Purser.

University of Aberdeen.

An Improved Mercury Vapour Trap.

Ingress of mercury vapour from mercury vapour condensation pumps into systems undergoing evacuation is prevented in practice by freezing out the mercury vapour in liquid air-cooled traps. The chief drawbacks to this method lie in the cost of liquid air and in the need of attention in replenishing the liquid air as long as the trap is required to remain in action.

Hughes and Poindexter (Nature, vol. 115, p. 979; 1925) described an alternative method of trapping mercury vapour by means of thin films of distilled alkali metal, either sodium or potassium. This method, whilst probably as efficient as freezing out by liquid air, suffers from the disadvantages that the surface of the metal soon becomes clogged, particularly with large pumps, and that renewal of the alkali metal film involves distillation of the metal; a process destructive of glass or silica apparatus.

During the last ten months I have used with complete satisfaction a liquid alloy of sodium and potassium in order to trap mercury vapour. The alloy is prepared by melting together, in an ine atmosphere, sodium and potassium in the proportion 1 to 2. The liquid alloy is then poured through tap funnel into the trap, filled with an inert ga and consisting of a twelve-inches long wide-bore glas tube provided with inlet and outlet tubes for attach ing to the pump and vessel undergoing evacuatio Oxides and scum remain in the tap funnel, clea alloy alone passing into the trap.

Mercury vapour is retained by the alloy in th form of a solid amalgam which collects on the surfac of the alloy. The latter may be oxidised to a con siderable extent before its powers of retaining mercur fall off to any considerable extent. Regeneration o the alloy surface can be simply effected either b shaking the trap and thus causing cracks to develo in the surface layer of amalgam or oxide, or, bette by sweeping the alloy surface free from such layer by means of a ball or coil of iron wire originall inserted into the trap and moved about therein b means of an external electro-magnet.

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Dug-out Canoe in Algoa Bay.

The canoe found on the shore of Algoa Bay an illustrated in Mr. FitzSimon's letter in Nature o May 21, p. 746, differs in several respects from thos of the Mawken or Selungs of the Mergui Archipelago During many months spent among those people, do not remember ever to have seen a Mawken canoe a kabang, in which the solid hull, apart from th palm stem bulwarks, did not have a gradual shee from amidships upwards to bow and stern. Bu more important still, the Selung kabang has a semi circular notch cut out of the prow and stern of th hull. These form steps by which it is safe and eas to climb into the canoe from the water. I feel sur that whatever may be the origin of the canoe foun in South Africa, it did not come from the Mergu Archipelago.

R. N. Rudmose Brown.

The University, Sheffield,
May 23.

I would suggest that, in order to find the hom of the canoe which Mr. F. W. FitzSimons discovere on the beach of Algoa Bay (Nature, May 21, p. 746) it is scarcely necessary to look across 5000 miles o ocean. Canoes of this type, with two upturned ends are commonly carried as tenders by the many Ara dhows which trade along the northern part of th east coast of Africa and from Port Sudan to Zanziba —and also along the west coast of Madagascar; ver similar canoes, either with or without outriggers, ar ordinarily employed by the local fishermen.

A model of one of these dhows' canoes may be see in the Ship-Model Collections of the Science Museum, South Kensington, and if viewed from the directio in which the photograph of the Algoa Bay derelic was taken, it shows a very close similarity in shape Owing, however, to the derelict having lost the ligh wash-boards which served to heighten its sides, th photograph gives an appearance of less depth amidships and of exaggerated height at bow and stern.

Instead of the upturned bow of the Algoa Ba canoe, the typical canoes of the Mergui Archipelag are built with the projecting bow, suggestive of th ram of late nineteenth-century warships, which is s commonly seen on the Irrawaddy.

G. S. Laird Clowes.

Science Museum,
South Kensington, S.W.7.

Rigidity and other Anomalies in Colloidal Solutions.[1]

By EMIL HATSCHEK.

THE technical definition of the term rigidity is arrived at by considering a cube of an elastic solid one face of which is held while a tangential force is applied to the opposite one. The cube undergoes a deformation called a 'shear' and resists it by virtue of a property called its rigidity, which causes it to return to its original shape when the force ceases to act. The terms of the experiment lead to a quantitative expression, the modulus of rigidity, that is, the force which, applied to a cube of unit dimensions, would produce unit deformation.

In a transparent isotropic material, such as gelatin jelly, a further change accompanies the deformation: the material becomes double refracting. This accidental double refraction is easily observed in polarised light and is a delicate means of detecting strains in transparent media.

It must be added that the rigidity of a perfectly elastic material does not vary with time, so that the stress required to maintain a given deformation remains constant.

Rigidity is one of the most characteristic properties of the solid state and absent in all normal liquids. The difference between solids and liquids is best realised by considering the ideal case of a liquid between two indefinitely extended parallel planes, one of which is fixed. If now a force, however small, is applied to the other, it moves, not only a small distance as with the elastic solid, but also continuously so long as the force acts and comes to rest when it ceases to do so. The force required to maintain a given velocity is proportional to the area of the plates and the velocity gradient, that is, the velocity of the moving plate divided by its distance from the fixed one, and depends on the viscosity of the liquid. A quantitative expression again suggests itself from the terms of the mental experiment: the force per unit area required to maintain unit velocity when the plates are unit distance apart; this is called the viscosity coefficient. In all liquids it decreases with rising temperature.

A very remarkable feature of this physical constant is that in all normal liquids it is quite independent of the velocity gradient. If all else is kept constant, the forces required to maintain two different velocities are exactly proportional to these velocities.

Instead of expressing the viscosity coefficient in the absolute units of the definition, it is customary in work on solutions, such as we shall consider, to express it as 'relative viscosity,' the viscosity of a standard liquid, generally the solvent itself, being taken as unity. Thus the relative viscosity of a 60 per cent. solution of cane sugar at 20° is 56·5.

Since a normal liquid yields at once to the smallest force, no deformation can be set up in it, nor the accompanying phenomenon of double refraction. Attempts to detect such an effect at very high shear gradients were first made by Kundt in 1881, and afterwards by other physicists, with negative results except in a few liquids which we now know to be colloidal solutions.

The arrangement of two parallel planes with liquid between them, from which the definition of the viscosity coefficient was deduced, is not realisable experimentally. We can, however, without materially altering the conditions, so to speak 'roll up' the two planes, and confine the liquid between two coaxial cylinders, the outer of which is rotated while the inner is at rest. Such an arrangement can be used for measuring viscosities and will be referred to again.

Historically, it is not the first device used for this purpose. The study of viscosity was begun by Poiseuille, who in 1841 discovered empirically the law, called after him, which governs the flow of a liquid through a capillary tube. This 'transpiration method,' as it was originally called, attracted the interest of Thomas Graham, the founder of colloid chemistry, who applied it to many colloidal solutions. He was so much struck with the changes in viscosity caused by the addition of electrolytes or by mere ageing, that in his famous paper on silicic acid he made the often quoted remark that "a liquid transpiration tube may be employed as a colloidoscope."

The transpiration tube, or, as it is now called, the capillary viscometer, was used by a large number of observers, generally in the simple form given it by Wilhelm Ostwald, in which the pressure causing the flow of liquid is produced by a column of the liquid itself. As measurements accumulated it became evident that many colloidal solutions did not behave like normal liquids, but the instruments in general use were theoretically inadequate to reveal the nature of their anomalies. On a somewhat different footing stands an investigation by Garrett, published at Heidelberg in 1903. He studied the viscosity of a number of colloidal solutions both in the capillary and by a method not used before. If a circular, horizontal disc suspended from a wire is made to oscillate round its axis in a liquid, the viscosity coefficient can be calculated from the damping effect. Garrett found in this way that colloidal solutions exhibited a number of bewildering anomalies. The values found by the disc method did not agree with those determined by the capillary; they were not even consistent among themselves, but varied with the amplitude of the oscillations and altered even during the course of the experiment. This investigation is quoted in all the text-books published about 1910 to show the complexity of the problem, but no very definite attitude towards it is taken up by the authors.

The first deliberate attempts to bring some light into the matter were made about this time by Prof. W. R. Hess, of Zürich, and by myself, working in ignorance of each other. Hess had been induced to attack the problem by practical considerations: measurements of the viscosity of blood had become a clinical method, but the results obtained by various observers were difficult to reconcile. Hess showed in an improved capillary viscometer that the viscosity of blood and of some colloidal solutions like gelatin was not a constant but varied with the shear gradient; the faster these liquids were sheared the less viscous they appeared to be, until above a certain gradient the viscosity coefficient became a constant.

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[1] Discourse delivered at the Royal Institution on Friday, Mar. 18.

In a theoretical paper published early in 1911, I had reached the conclusion that colloidal solutions of a certain type should have a variable viscosity which should become constant above a certain velocity gradient. I proceeded to test these conclusions in a modification of the concentric cylinder apparatus which was first used by Couette in 1890.

This apparatus consists of an outer cylinder, which can be rotated at constant speed, and an inner cylinder coaxial with it and suspended from a wire. When the outer cylinder revolves, the viscous drag of the liquid carries round the inner one, until the torsion of the wire balances this drag. If all end effects are eliminated—which can be accomplished by screening the ends of the inner cylinder by suitable fixed guards—theory shows that the deflexion of the inner cylinder, which is read with telescope and scale, is exactly proportional to the product of angular velocity into viscosity.

The first results obtained with this apparatus were published in 1913. Dilute gelatin solutions were investigated, and the viscosity was found to decrease rapidly with increasing velocity: at 10° per sec. it was about 2·5 times as great as at 100° per sec. The curves representing the variation of viscosity with velocity all show a tendency to become horizontal at high velocities, and to rise asymptotically at low velocities. The same behaviour has been found in a very large number of colloidal solutions, examined either in the concentric cylinder apparatus or in improved forms of the capillary instrument, in which the rate of flow can be varied. In a few instances apparent exceptions have been found by some observers, *i.e.* viscosities which appeared to be constant. These discrepancies have been cleared up by extending the range of investigation to much lower velocity gradients, when the usual behaviour could be demonstrated again. Increasing viscosity with decreasing shear gradient may now be considered a general property of colloidal solutions.

Since this behaviour is thus characteristic of a large and important class of liquids, and in the most striking contrast to that of normal liquids, it is of great importance to find some explanation of it. One suggested by several authors, including Prof. Freundlich, is that these solutions, unlike normal liquids, possess rigidity as well as viscosity. It can indeed be shown mathematically, by making the simplest assumption regarding this rigidity, that the result will be what has been found experimentally, namely, decreasing viscosit with increasing velocity gradient.

The suggestion that solutions which nobod could hesitate to describe as liquids should posses one of the fundamental properties of solids is s surprising, that one is naturally anxious to have direct demonstration rather than an inference from mathematical treatment. There is no difficulty in providing this demonstration with delicate apparatus, which permits measurements of the modulus to be made. I have, however, been fortunate enough to discover a solution, the rigidity of which can be demonstrated without any apparatus at all, namely dilute ammonium oleate. If a freshly prepared solution is given a rotary movement in a beaker it gradually comes to rest like any other liquid, but then *rotates backwards*.

The ammonium oleate solutions are mechanically very labile systems, the elastic properties of which depend on their age and previous treatment. In view of their marked rigidity they appeared to be excellent test objects for the assumption that it was this property which caused variable viscosity. Examination, however, revealed the further striking anomaly that these solutions had viscosities which varied even at constant velocity gradient and oscillated periodically between well-marked maxima and minima.

This anomaly fortunately is unique, although a decrease in viscosity after continued shearing is quite common. As regards rigidity, no other solution so far examined shows it in the same striking manner as ammonium oleate, and special apparatus is necessary to demonstrate it and to measure the modulus. The first measurement of this kind was carried out by Schwedoff in 1889 on a 0·5 per cent. gelatin solution; a series of such solutions was investigated by Rohloff and Shinjo at Göttingen in 1907. We were desirous of studying solutions other than gelatin, more especially those which had shown markedly variable viscosity, and employed Schwedoff's method for the purpose.

This method again uses the artifice of confining the liquid between concentric cylinders, the inner one being suspended from a wire. If now a certain torsion is given to the wire, and if the liquid between the cylinders is merely viscous, the suspended cylinder begins at once to follow the wire and continues to do so, until no torsion is left in the wire. If, however, the liquid has rigidity, the cylinder does not follow, but describes a much smaller angle than that by which the wire has been twisted, and remains in this position for some time, the rigidity of the hollow cylinder of liquid now balancing the torsion. From the two angles and the constants of the apparatus the modulus of rigidity can be calculated.

All the liquids we have examined lose their rigidity at or below 40°, and, to obtain a satisfactory zero, they are charged into the apparatus at this temperature and allowed to cool in it for twenty-four hours before measurements are made. The moduli are of the order of *milligrams per sq. cm.*, whereas the modulus of 10 or 12 per cent. gelatin jellies is about 100 grams per sq. cm. and that of metals of the order of tons per sq. cm. Solutions of ammonium oleate, gelatin, benzopurpurin, and cotton yellow (two dyes), and of mercury-sulphosalicylic acid, have been studied in this fashion. In all of them the modulus increases with age; a corresponding increase in viscosity has been known to occur for some time.

Since these liquids can support a small deformation, one may expect them to exhibit accidental double refraction, and they all do so, though in very different degrees. The phenomenon is most strikingly shown by quite dilute solutions of cotton yellow and of mercury-sulphosalicylic acid, when they were stirred or caused to flow. This accidental double refraction disappears with the rigidity on heating.

Although the solutions described exhibit measurable rigidities, the properties of the liquid state yet manifest themselves inasmuch as, unlike elastic solids, they do so for a short time only; very soon the phenomenon called by Maxwell 'relaxation' sets in and, in the apparatus described, the inner cylinder gradually follows the wire. From the constants of the apparatus and the time required for a given angular displacement the viscosity of the liquid at extremely low velocity gradients can be calculated; a number of determinations have been made at speeds which correspond to one revolution of the viscosity apparatus described above in 7·5 days, while the lowest speeds so far used have been of the order of one revolution in 2·5 *minutes*. At these very low velocity gradients the relative viscosities (water = 1) approach 100,000, which confirms the result of a very large body of measurements at ordinary gradients, namely, that the viscosity with decreasing gradient grows asymptotically and at infinitely small velocities really becomes infinite.

We thus have a considerable body of evidence for the existence of rigidity in many of the solutions which exhibit anomalous viscosity, and numerous series of measurements of the latter over a wide range of velocity gradients. As regards the causes of these anomalies we are still in the dark, although there has been no lack of the *ad hoc* hypotheses which are characteristic of a vigorously growing discipline like colloid chemistry. To explain the anomalies it has been suggested that the particles forming these solutions have peculiar shapes and arrange themselves in a special manner; although the particles are of much larger than molecular sizes, they are yet supposed to be modelled on the shape of the molecule. Thus the long chain molecules of the fatty acid salts, or the long chains of amino-acids forming proteins like gelatin, are assumed to produce filamentous aggregates or ramifying structures. There is little direct evidence of such structures, since most of the solutions in question show no particles in the ultra-microscope, and the extreme chemical diversity of the substances the solutions of which show anomaly makes the explanation at least inadequate. While compounds like the oleates undoubtedly have long chain molecules, the mercury-sulphosalicylic acid is a very simple aromatic compound of a type which makes chain formation difficult to conceive.

It is, however, not only the extreme diversity of chemical structures which makes such attempts at explanation unconvincing, but also we have experimental evidence showing beyond any doubt that variable viscosity can be produced by simply suspending in a normal liquid a small volume percentage of microscopic particles of nearly spherical shape. I showed in 1916 with Dr. Edith Humphrey (and the measurements have since been repeated and extended) that such suspensions (of rice starch in an indifferent organic liquid of the same density) exhibited viscosities which varied with the velocity gradient exactly as do the viscosities of colloidal solutions: with decreasing velocity the viscosity grows asymptotically, while with increasing velocity it approaches, and in the lower concentrations reaches, a constant value.

There is no evidence, and certainly no probability, that such particles aggregate into chains, and the cause of the variable viscosity must therefore be sought, not in their configuration, but in some effect which they produce on the surrounding liquid. There is a very large amount of evidence drawn from the most diverse phenomena to show that particles in a liquid are surrounded by films or layers of it in which the properties of the liquid are altered. The viscosity measurements on suspensions suggest that these layers must extend some distance into the bulk of the liquid and must be sufficiently labile to be affected by the shearing of the liquid. These considerations would apply to all particles, whatever their shape or arrangement, and the combined effect of these factors would necessarily be complicated.

There is a further strong argument for the view that the cause of the anomalies of these solutions has to be sought partly or largely in some change in the solvent, and that is the striking uniformity of their behaviour regarding temperature. Solutions of substances differing as widely as possible in their chemical constitution behave alike, inasmuch as they lose their rigidity about the same temperature, namely, 40°. It seems natural to look for the reason of this uniformity in the factor common to all the solutions, the water, for the properties of which this temperature is significant.

There is no doubt that the anomalies here discussed have an important bearing on processes in organisms, all of which consist largely of colloidal material. It is impossible to enter on so vast a subject, but attention must be directed to the general physical aspect of rigidity and variable viscosity in colloidal solutions. It is known that under enormous pressures solids behave like liquids, *i.e.* flow; colloidal solutions exhibit the converse behaviour: under exiguous stresses they approximate to the behaviour of solids by exhibiting rigidity and enormous viscosities. Many of them pass continuously into jellies which, within limits, behave more and more like elastic solids, and these colloidal systems thus provide a remarkable series of transitions from the liquid to the solid state.

The Progress of Hittite Studies—II.[1]

By Prof. J. Garstang.

The new documents bearing on home affairs, though numerous, are not easy of interpretation. It is known from a cursory examination of more than 2000 fragments that the subject matter includes kings' speeches, chronicles and decrees, wills, deeds of gifts and patents of nobility, treaties, legal agreements, inventories (both civil and military), registers of landed property, codes of law as well as detailed military regulations. A large proportion deals with religious matters, including descriptions of festivals and ritual; prayers and legends; questions for the oracles, soothsayers' texts, incantations, and so forth. There is evidently material for reconstructing the social institutions and organisation of Asia Minor under the Hattic kings that will in due time become intelligible. Already, notwithstanding the difficulties of language, the nature of the kingship and government, and the military organisation of the confederated states may be discerned in outline with a measure of certainty.

The Hattic kingship was essentially military, and it was established on a feudal basis. All lands and offices were received from the king on terms of service, whether military or civil. All officers and functionaries were sworn in to personal loyalty, from the viceroy to the royal shoemaker. In the wider aspect of the Great-King as head of the vassal or allied Hittite states, the same principle prevailed. Each king or chieftain owed military service to the central throne, whether by way of levies to the standing army or terms of special service. When princes were enthroned or re-enthroned after revolt, the terms of service were defined by treaty. This applied to conquered territories of non-Hittite or not purely Hittite peoples. Thus the kingdom of Arzawa on the southern coast, which appears frequently opposed to Hattic rule, was dismembered by Muršil III. after one such revolution, and each state was separately bound by agreement to fealty and military obligations. In the time of imperial domination over the states of northern Syria (the fourteenth and thirteenth centuries B.C.) the duties of each vassal in regard to the Great-King's wars were defined and their relations towards one another were dictated to them. The powerful Amorite rulers of the Lebanon area were treated with a certain measure of respect, but even they were bound to join their forces to the Hittite armies in the greater enterprises, and among these the possibility of a conflict with Egypt was foreseen.

While the king's position as head of the army was absolute, and his dominion over the vast agglomeration of Hittite states and conquered territories was maintained by a ready sword, yet in the conduct and organisation of military affairs there was an accepted procedure and code of regulations. The position, rights, and duties of the army, its units and its leaders, were carefully and strictly defined. Army orders covered all such questions as the requisitioning of private property, reservation of quarters, lodging of prisoners, guard duty, the construction of camps—even to the detail of the dimensions of ramparts and ditches and the length of palisades when encamped in enemy country. It is also noteworthy that proper personal credit is given to the generals and officers. A sense of social equity pervades the records, in which the historical sense was equally impartial, no difference being seen in the narrative of events whether to the glory of the king or of his generals, or even when revealing the weakness of either.

This sense of equity finds its official expression in the constitution of a general assembly to advise the king on questions of law and constitutional procedure. The princes of allied and vassal states had their places at this meeting and many of them held high office or high titles at the court itself. The system permeated the administrative organisation of the land: each principality had its local assembly and each township its council of elders. The constitutional history of the later empire suggests, in fact, the presence of the same tendencies, and much the same processes at work, as later in early England.

By the side of the military absolutism, modified by gradual infiltration of democratic principles, there is always visible a theocratic element of power around the throne. The king was hereditary High Priest of all the gods. His duties and functions at the chief rites were formulated and are preserved. Before and after his campaigns the young warrior Muršil III. never failed to invoke the blessing of the sun-goddess of Arinna, the maker and dethroner of kings, mistress of oaths, and goddess of war—and to render to her all the glory of his successes. This duty was not self-imposed. A deep religious sense permeates numerous documents and was evidently a national heritage, and an offence against the gods might involve national disasters. Some of the latest documents reveal this element most strongly, and in several parts of Asia Minor, as is well known, the theocratic system survived the military kingship. Until earlier documents give their evidence it is not possible to say whether this tendency was a new and growing one, or whether, as would seem more likely, the military rule of the Hattic kings was originally imposed upon a theocratic society, of which, as in religious worship, it assimilated the strongest elements. It is significant that while the duties of the priests were laid down in detail, they were restrained from holding property of any kind except by royal gift and favour.

In regard to the organisation of the land, with its numerous principalities and fiefs, there are many important documents of which the full interpretation is not yet possible because the geographical names are unfamiliar. The outline of the picture is clear but the detail is confused.

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[1] Continued from p. 820.

The interpretation of documents relating to foreign affairs has been greatly facilitated, not only by the Semitic language of the texts but also by the fact that names of places in the Semitic world are in some cases permanent or at least transparent. An immediate example of survival is the name of Aleppo, namely, Ḫalab, or Ḫalpa, which is essentially the same to-day, and was so in Egyptian. In other cases tentative identification based on similarity of sound or general indications of position can be checked by comparison with parallel documents from Egyptian or other sources. Thus the name Yaruwaddaš (written also Yaruwandaš) scarcely disguises the name of Arvad, Egyptian Aruad, the island city near modern Tripolis on the coast of Syria. The equation is confirmed by reference to the Amarna letters, in which the same persons and situations are mentioned as in Hittite documents. Working on these lines, certain points may be fixed (*e.g.* Kinza = Kodshe = Kadesh), so that narratives of campaigns may be followed on the map, and in so doing other identifications can be tentatively formulated with due regard to the physical and political geography of the areas involved.

The documents concerning Asia Minor, however, contain hundreds of place names which have not survived the various changes of race and language, and except for the capital itself (the name of which has also disappeared), there is scarcely a fixed starting-point upon which students are agreed. The few maps published by German scholars accordingly show profound and disappointing differences. Nevertheless, possible clues may be found in the grouping of the names, having regard to the physical features of the country, and the possibility of some surviving sound-elements in classical or Turkish names. Thus a town Wi.ya.na.wa.an.da, grouped with a river Aštarpa, which is a boundary of a district Kûwalia, with which in turn there is associated a boundary River Šiyanti and a tract called Mira, suggest respectively the Lycian Oeneanda (the digamma disappearing), the River Isparta (an assimilation by metathesis to a local and relatively recent place name), the district of Kabalia (the digamma this time becoming *β*, a tendency noted by Ramsay, *H.G.* p. 22), together with the Eshenide River or Eshen (classical Xanthos) and the district of Milyas (Lycian Mira). This grouping in Lycia accords precisely with the indications of physical and classical geography; but Dr. Forrer, whose line of attack is different, places the same group in the east of Cilicia, where also was a classical name Oeneanda. In the latter district, moreover, some English scholars would locate an entirely different state called Kizzuwadna.

Another group of Hittite names, from a list of hiera, which is several times repeated with variations, associates:

Dunna . . . Ḫubšina . . . Tuwanuwa . . . Laanda and Maššuḫanda.

With these may be compared the Cappadocian group from Ptolemy (Cataonia, etc.):

Tynna . . . Kabassos (? Kybistra) . . . Tyana . . . Leandis and Mazaka.

The identity of Tyana is generally admitted; and the suggested identity of Maššuḫ-anda with Mazaka recalls the tradition that its founder was Mošoḫ (cf. Meshekh), which may account for the composition of the Hittite name. In this way, group by group, a working theory of the identity of the Hittite places, and so of the disposition and military organisation of the Hittite states, can be constructed. In it a number of names appear to survive plausibly; *e.g.* Alše as the Assyrian Alze (Arzen); Damašḫunaš as Damascene; Ḫumiššenaš as Komisene; Ḳuššar, of which the variants are Kuššara and Kuššaraš, and the latest form apparently Gaz-zi-u-ra-aš, as Gaziura (Strabo xii. iii. 15); Kuwanna as Kuwania (Konia); Teburzia as Trapezus (Trebizond); Urušša as Eriza; Zimurria as Zimara, etc. The result shows the main political divisions which are based upon physical features to have been permanent. Thus the central Ḫatti state is represented generally by Cappadocia; the allies of Arzawa and Kizzuwadna reappear as Cilicia and Pontus respectively, Gasga as Lesser Armenia; while the rival state of Ḫarri was the forerunner of Armenia, east of the Euphrates.[1]

In general it may be argued that the power which resisted for centuries the old monarchies of Egypt and Babylonia and occasionally challenged them in Syria was presumably master of all Asia Minor. In particular the control by Ḫatti of the passes of anti-Taurus towards the Euphrates and Syria may be assumed; and the general resemblance of the Hittite monuments, borne out by comparison of details, may be adduced in support of the view that nearly all the monuments characterised as Hittite by special hieroglyphs or symbolism throughout south-east Cappadocia and anti-Taurus (including the palace sculptures of Marash and Malatia) are Hattic in inception. The result indicates a strategic organisation of the south-east frontier which is accordant with its physical features and the course of history.

Turning to the rest of Asia Minor, the names in the north-west are more baffling than elsewhere, possibly owing to the Phrygian and other historical immigrations. But the line of monuments along the main highway from the capital to the coast near Ephesus, is evidence of an extension of Hattic dominion to the Ægean, at a time more or less contemporary with the religious sculptures of the capital.

The menace and gradual penetration of the Achæans on the western and southern coasts provides further evidence that the later Hattic kings regarded these tracts as within their dominion. The attempts of the newcomers to settle on the Carian coast in the thirteenth century have been indicated by Dr. Forrer. In amplification of his thesis, we may point to a group of names mentioned in connexion with the expedition by sea with 100 ships of Attariššiyaš (who is identified tentatively with Atreus by Forrer, and with Perseus by Sayce). Among these names (Wallarimma, Ḭalanti, Bitašša, Marašа, and Millawanda) there appears the unusual form Khuršunašša, which seems to equate perfectly with Khersonesos, and so to give a clue to the identity of the whole. Accordingly the following possible identifications may be suggested, following the same order: Hillarima, Alinda, Pedasa, Mylasa, and Miletos respectively. The last is based on the analogy and variant forms of Yaruwaddaš. If these equations stand test, it would appear that the coast at any rate preserved its Hittite names remarkably, unless indeed the texts are quoting names which, as in Syria, were new or foreign to the Hittite scribes.

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[1] For a fuller discussion and map, cf. "Index of Hittite Names" (Sp Publ. of the British School of Archæology in Jerusalem).

However that may be, two further points respecting the Achæans' movements may be mentioned. Repulsed from Caria, they gained a footing in Cyprus about 1226 B.C. Almost immediately they are found in company with Trahu and Luku, as well as Shekelesh and Sherdenu, raiding the Egyptian coast in the time of Merenptah. Their base in Cyprus explains the association about which there has been much uncertainty, suggesting a local geographical group in which the Akwesh (Achæans from Cyprus) are combined in this adventure with peoples from Tarshish and from Lycia, as well as others possibly from Sagalassos and from Sardis.

Lastly, it is becoming apparent that these texts connected with the Achæan penetration are gradually unfolding the background for the Trojan War. For in the time of Mutalliš (c. 1288) various new peoples with Trojan names, Derden, Luka, Pedes, Kelekesh, and others, are found newly leagued with the Hittite king against the Pharaoh. About the same time appears the name of Alakšanduš as an ally of the Hittite and settled by treaty at Uiluša (? Elaeusa). Greek legend also tells how Paris on his return from Egypt and Syria (according to one version of the story of Helen) was hospitably entertained by the 'Assyrian' king 'Motulos.' Whether this prove relevant or not, there is definite indication in these records that while the Achæans were menacing by sea the western and southern coasts of Asia Minor, the Dardanians were already being accepted as allies by the monarch and peoples of the mainland. The clash of arms around Troy (which by name Taroisa already appears in the texts) was but one crisis in the struggle which heralded the downfall of the Hattic empire. For long critical centuries European civilisation and society had been taking shape, protected by the Hittite organisation in Taurus and Anti-Taurus against the older ambitious monarchies of the Euphrates and the Nile. With the rise of the Iron Age, when Europe was able to fend for itself, the old Hittite barrier gave way.

Obituary.

PROF. EDOUARD BRÜCKNER.

THE death of Prof. Edouard Brückner at the age of sixty-four years, which took place at Vienna on May 21, removes a figure well known to both meteorologists and geologists. Brückner was born at Jena on July 29, 1862, his father being Alexander Brückner, the historian, which may account for the historical bias of his early meteorological work. He received the degree of Ph.D. at Munich in 1885, and from 1886 until 1888 he acted as assistant editor of the *Meteorologische Zeitschrift*. It was during this period that he discovered the weather cycle of 35 years which is universally known as the Brückner Cycle. During the next two or three years he collected a great deal of statistical evidence in support of this cycle, which he published in 1890 under the title: "Klimaschwankungen seit 1700," now one of the classics of meteorology.

Brückner's life-work was not mainly meteorological, however, for in 1891 he became professor of geography at Bern, and in 1906 professor of geography at Vienna, and although he continued to publish occasional meteorological papers so late as 1918, the main interest of the second half of his life was in the Quaternary history of the Alps, a subject in which he collaborated with Albrecht Penck. The fruit of this collaboration was a series of three large volumes, containing 1199 pages, published between 1901 and 1909—"Die Alpen im Eiszeitalter." To appreciate the service which this work did for glaciology, one must consider the position of the science in 1900. The battle between the supporters of one and of several glacial periods still raged hotly, the nomenclature was confused, and the wildest ideas of chronology prevailed. The thoroughness and minute detail of "Die Alpen im Eiszeitalter" decided the battle in favour of the polyglacialists, laid the foundations of a sound chronology, and provided a standard of reference and nomenclature which, by the general acceptance it compelled, has rendered incalculable assistance to glaciology in all parts of the world.

DR. VIKTOR ROTHMUND, professor of physical chemistry in the German University at Prague, died on May 10, at the age of fifty-seven years. A native of Munich, Rothmund was appointed to a lectureship at the University of Munich in 1898, which he held until 1902, when he was appointed to the chair at Prague. His published papers deal with a variety of subjects, including solubility, ozone, hydrogen peroxide, perchlorates, permutit, and the passivity of metals.

WE regret to announce the following deaths:

Dr. Carl H. Eigenmann, professor of zoology and dean of the graduate school of the University of Indiana, known for work on the variation, distribution, and embryology of fishes, on April 24, aged sixty-four years.

Prof. W. Lochhead, emeritus professor of biology in Macdonald College, McGill University, known for work on insect and fungus pests of orchards, on Mar. 26, aged sixty-two years.

Mr. W. H. Shrubsole, who worked on modern and fossil diatoms and related forms and was awarded the Lyell Fund of the Geological Society in 1898, on May 19, aged eighty-nine years.

Prof. William Carleton Williams, professor of chemistry at the University of Sheffield from 1883 until 1904, on May 25.

News and Views.

THE list of honours conferred by the King on the occasion of his birthday on June 3 includes the following names of men of science and others associated with scientific work: *Order of Merit:* The Hon. Sir Charles Parsons, in recognition of his eminent services in scientific research and its application to industries. *G.B.E. (Civil Division):* Sir Frank Heath, until recently Secretary to the Department of Scientific and Industrial Research; and Sir Richard Threlfall. *K.B.E. (Civil Division):* Dr. C. E. Ashford, Headmaster of the Royal Naval College, Dartmouth. *Knights:* Mr. W. G. Lobjoit, until recently Controller of Horticulture, Ministry of Agriculture; and Prof. C. J. Martin, Director of the Lister Institute, London. *C.M.G.:* Prof. R. W. Chapman, professor of engineering in the University of Adelaide. *C.I.E.:* Mr. A. G. Edie, Chief Conservator of Forests, Bombay. *C.B.E. (Civil Division):* Mr. D. J. Davies, Government Analyst, Department of Public Works, Newfoundland. *O.B.E. (Civil Division):* Mr. G. W. Grabham, Government Geologist, Khartoum; Mr. T. F. Main, Deputy-Director of Agriculture, Bombay; and Mr. V. E. Pullin, Director of Radiological Research, War Office.

THE new Science School at Clifton College, an account of which is given on p. 871 of this issue, was formally opened on Thursday, June 2, by H.R.H. The Prince of Wales. The boys gave a rousing welcome to their distinguished visitor, who was received at the Memorial Gate by the president of the College (Field-Marshal Lord Haig) and the headmaster. After lunch in the School House, the Prince proceeded to a dais outside the new building, where he made a felicitous reply to short speeches given by the president and headmaster. Referring to his presidency of the British Association, he said that it had brought him into touch with what was more or less a new world to him—the world of science—and had given him many new interests and new contacts. In declaring the new building open, he expressed the hope that it might prove the cradle of many future men of science—of future Faradays, or Kelvins, or Tildens—who would win further laurels for British learning and confer on all humanity benefits equal to those conferred by these great men in the past. He also laid emphasis upon the value of some training in science even to those who in later life were not to embark upon a professional scientific career. A number of presentations were then made, including representatives of the donors, the architect (Mr. Alan E. Munby), the head of the department (Mr. E. J. Holmyard), and the head of the physics department (Mr. W. C. Badcock). Many distinguished representatives of science and other branches of learning were present, and they were much interested in the display of books in the fine library in the new building, where an exhibition had been arranged. Clifton is fortunate in possessing the copy of Dalton's "New System" formerly belonging to William Henry, to whom the book was dedicated; a copy of Tyndall's "Faraday as a Discoverer," presented to Mrs. Faraday by Tyndall himself; a copy of Cannizzaro's works presented to Victor Meyer by the author; a copy of Avogadro's "Fisica" with an inscription in the author's hand; and first editions of Newton, Boyle, and Galvani. It also has a large collection of books on alchemy and early chemistry, so that if Clifton does not rear a succession of historians of science it will not be through lack of early opportunity.

A SURVEY prepared by Science Service of the recent legislative season in the United States discloses what appears to be a temporary collapse of the great anti-evolution drive in the various State legislatures. During the past winter and spring no less than twelve State legislatures had anti-evolution bills brought before them and all twelve have adjourned without the passage of a single one of the measures. In six of the States—California, Delaware, Minnesota, New Hampshire, North Carolina, and North Dakota—the bills did not even reach the floor of their respective Houses, but were disposed of in committee by decisive or unanimous votes. In Missouri, declared to be a pivotal Fundamentalist State, the bill reached the House, but was there rejected by 82 votes to 62. In West Virginia and Oklahoma similar bills were defeated by House votes of 57 to 36 and 46 to 30 respectively. An aggressive campaign in Arkansas resulted in an anti-evolution bill passing the lower house by a very close margin, but it was rejected in the Senate by an overwhelming aye-and-nay vote. In two States, Alabama and South Carolina, anti-evolutionist bills have been temporarily shelved. In Florida, where the legislature meets later in the year than in other States, a bill is at present being hotly debated, predictions being that it will not pass. In Tennessee, one of the two States where an anti-evolution bill has become law, there prevails considerable doubt amongst legal authorities as to its interpretation; and in Mississippi the law has not yet been tested in the courts.

THE Education Association of the Southern Methodist Episcopal Church in the United States has condemned the anti-evolution legislative programme. The resolution was introduced by the president of Duke University, one of the largest and most influential of southern educational institutions, and only two delegates voted against it. Prominent southern Baptist churchmen have also declared themselves as opposed to legislative restrictions on teaching. All the other churches have fought this wave of obscurantism virtually from the start; but the southern Methodists and southern Baptists are by far the most numerous bodies in the American south, and their attitude is highly significant. On the whole, in spite of a new movement recently set on foot to organise local opinion against the appointment of 'evolutionist' teachers, or to try to secure their dismissal, the situation seems not unsatisfactory. The future seems to depend upon the ability of the teaching profession in America to resist what may be called the dictatorship of the illiterate.

A RECENT article published in NATURE (April 2, p. 481) on the subject of the scientific slaughtering of animals has elicited an interesting letter from Mr. Herbert Kidd, 331 Franklin Street, San Francisco, contrasting the British and American methods of slaughtering. From this letter it would appear that the subject has hitherto attracted far less attention in America than in some European countries, and that the modern method of the captive bolt pistol is very little used there. Mr. Kidd states that cattle are stunned with a sledge-hammer, the Argentine practice of afterwards pithing with the stem or handle having been abandoned because it involves the loss of about ½ lb. of meat per beast through bruising. Sheep are killed on the floor at the high over-all rate of 6 sheep per man per hour; and the spinal cord is not severed. Mr. Kidd's letter brings out a point which gives a good deal of trouble to those who are concerned about this backward aspect of civilisation, namely, the great variations in local practice which make generalisations on the subject precarious: a standard practice throughout the world of the method which has been found statistically to be the most humane is much to be desired. It would be interesting to know the position as regards small private slaughterhouses in a country where large-scale operations are so common as in America: in England (as contrasted with Scotland) local authorities which have built public abattoirs are unable to work them at a profit because they have no power to close the competing private slaughterhouses, either with or without compensation.

A SMALL booklet has been issued by Mr. Ernest A. Chapman, 69 Hayter Road, London, S.W.2, with the view of further elucidation of four small pearl shells which are not only very peculiar and highly interesting in themselves, but also seem to have had a curious history. The pamphlet is very carefully illustrated with excellent photographs, and any one interested should be able to gain a fairly complete idea of the problem from it. The four shells are really four similar valves, none of them having its partner. Each valve contains a pearl attached to the shell by nacre deposition. It is stated that experts in four continents have been consulted without success, and that eminent conchologists in Great Britain are of opinion that the shells belong to an extinct or unknown species. They have been heirlooms in the possession of a family in the south of Ireland for many generations, but no knowledge is forthcoming of how they reached that family. The names of several well-known experts are mentioned in the pamphlet, and the reader is left with the statement that they regard these little shells as a unique set, the only specimens of the type seen or reported.

PROF. W. J. DAKIN, Derby professor of zoology in the University of Liverpool, has been kind enough to examine the shells on our behalf, and he states that he is not prepared to accept the views put forward in the pamphlet. "It seems rather singular," he says, "that the four shells should be so like in appearance, and each with a blister of the same large size in the same place. There is also no doubt that the margins of the 'shells' and the hinge lines have been trimmed and polished. It seems probable that the 'shells' are not real in the natural history sense at all, but have been carved from the nacreous part of a larger pearl shell. I do not agree with the statement that the shells are too deep for this; such is decidedly not the case. Neither can it be admitted that artificial work would be more easily detected. It is not fair to compare what an amateur might do with what can be done by an accomplished Oriental worker. There remains to be granted an extraordinary resemblance (indicated by Prof. Morley Davies) to an extinct Miocene species which is depicted in the pamphlet. It is not, however, altogether convincing. Shell collectors and others who have been interested in cameos and curios carved out of mollusc shells might take a hand in solving this tantalising little puzzle."

THE seventh annual report of the British Non-ferrous Metals Research Association shows rapid growth. The total expenditure on research during 1926 was £22,000, and that figure will be increased during the present year. The period of full Government grant has now expired and that source of income diminishes progressively, but sufficient support is being received from the industry to continue the research work on the same scale. It is remarkable, however, that even now prominent firms sometimes fail to take advantage of the scientific results of the investigations and withdraw the support which they have previously given. A study of the report will show that manufacturers have everything to gain by becoming members of such an organisation. Among the investigations which are making good progress and are of general interest are those concerned with the wastage of locomotive firebox stays, in which all railway companies are interested, and the deterioration of lead cable sheathing, which is of importance to the telegraph and telephone industries. Much is expected of the investigations in hand on materials capable of resisting high temperatures, and valuable results have already been obtained in this direction. Researches on electro-deposition and on methods of casting and jointing have engaged the attention of many workers, and the combined researches on die-casting are doing much for an industry which is of growing importance. Among other activities the Association has made a survey of annealing furnace practice, and has been able to advise as to improvements in annealing practice. The report contains much that is of interest to metallurgists in general.

RADIO communication is proving of great value to isolated communities on various parts of the earth's surface. For example, the lonely Farsan Islands in the Red Sea, which are about 400 miles north of Aden and the same distance south-east of Port Sudan, are being examined for oil by the Red Sea Petroleum Company. The prospectors are equipped with an ordinary Marconi ship's transmitter. Through the neighbouring ports, or through any of the large number of ships within radio range passing up and down the Red Sea, they can easily link up with main telegraph circuits, and also secure, if necessary, medical advice and other assistance.

The new short wave beam stations enable news to be transmitted to the Dominions much more rapidly than by ordinary radio services. Last year it took sixty seconds to transmit the name of the winner of the Derby to the Melbourne central telegraph office. This year the name of the winner was transmitted in three seconds, and in fourteen seconds after the finish of the race the full result was known in all the principal newspaper offices in Australia. This result was equalled on Budget day this year, only a few days after the beam stations had been handed over to the General Post Office. A thirteen-word 'empiradio' message, giving the first news of the Budget, was transmitted to Australia in thirty seconds.

On Tuesday, May 24, Mr. J. L. Baird gave a successful demonstration of television between Motograph House, London, W.C.2, and the Central Hotel, Glasgow. Two ordinary Post Office telephone lines were used, one being for conversation and the other for the television transmission. The inventor has simplified the method of synchronising the two machines employed by means of a new arrangement of filter circuits. The telephone lines connecting the two stations were 438 miles long. Possibly owing to induction effects with neighbouring circuits the images were sometimes unsteady, but in most of the experiments they were steady and clear. Instructions given through the telephone to the operator at London were shown by the image to be immediately obeyed. Arrangements are being made to demonstrate television between London and New York.

A new observatory on Kilauea—the Uwekahuna Observatory and Exhibition Room of the Hawaiian Volcano Research Association—was opened on April 19 (*Volcano Letter*, April 21). It is intended for the use of visitors, to explain to them in an appropriate setting the mechanism of volcanoes. Built on the highest rim of the Kilauea crater, the view from it includes Mauna Kea and Mauna Loa, the cones of the Kau Desert, and the Halemaumau pit, the latter a great chasm less than a mile away, as well as all the details of the Kilauea crater.

On June 6, Mr. Clarence Chamberlin and Mr. Levine landed at Eisleben after a non-stop flight from New York of about forty-three hours. Thus Capt. Lindbergh's record for distance and time in the air without landing, set up so recently as May 22 last (Nature, May 28, p. 792), has been broken. Mr. Chamberlin, with Mr. Levine as passenger, started on June 4 at 6·5 A.M. in a Bellanca monoplane, the *Columbia*, and was forced to land at 5·35 A.M. on June 6 by the exhaustion of his petrol supply, after covering a distance estimated at 4400-4700 miles. The machine was fitted with a 200 h.p. Wright "Whirlwind" radial engine and was in other respects similar in type to that used by Capt. Lindbergh.

An expedition under the leadership of Mr. G. P. Putnam to Baffin Island is announced in a recent issue of *Science* (No. 1689). The expedition will leave New York this month in the schooner *Morrissey*, and will be under the auspices of the American Geographical Society, the Museum of the American Indian, and the American Museum of Natural History. The course is to be through Hudson Strait to Fox Basin, which is one of the least explored parts of Arctic Canada. Most of its eastern coast is still uncharted. Expeditions into the interior of Baffin Island will be attempted. The main aims of the party are the collection of zoological and anthropological specimens.

At the recent annual meeting of the U.S. National Academy of Sciences, Prof. T. H. Morgan, of Columbia University, distinguished for his work on hereditary processes and evolution in animals, was elected president. Dr. F. E. Wright, of the Carnegie Institution of Washington, was elected vice-president of the Academy, and Dr. David E. White, of the U.S. Geological Survey, was re-elected home secretary. Three new members of council were appointed: Prof. George E. Hale, Mount Wilson Astronomical Observatory; Dr. John C. Merriam, president of the Carnegie Institution of Washington; and Dr. J. McKeen Cattell, editor of *Science* and other scientific publications.

The following were elected members of the U.S. National Academy of Sciences at the recent annual meeting: Eric Temple Bell, professor of mathematics, California Institute of Technology, Pasadena, California; Charles Peter Berkey, professor of geology, Columbia University, who has recently made investigations of the ancient rock layers of Asia; William Bowie, chief of the Division of Geodesy, U.S. Coast and Geodetic Survey, Washington, an authority on isostasy; Arthur Holly Compton, professor of physics, University of Chicago, known for his work on the Compton effect; Benjamin Minge Duggar, botanist of the Missouri Botanical Gardens, St. Louis, known for his work on plant diseases and plant physiology; Thomas Alva Edison, the distinguished inventor; Rollins Adams Emerson, professor of plant breeding, Cornell University; Herbert McLean, professor of anatomy, the University of California, the discoverer of vitamin E; William King Gregory, curator of palæontology in the American Museum of Natural History; Edwin Powell Hubble, of the Mount Wilson Observatory, California, known for his work on distant nebulæ; Claude Silbert Hudson, chemist at the U.S. Bureau of Standards; Alfred Newton Richards, professor of pharmacology at the University of Pennsylvania; Francis Peyton Rous, physiologist of the Rockefeller Institute for Medical Research, New York City; who has done fundamental work on the nature of cancer; Albert Sauveur, professor of metallurgy at Harvard University; Henry Van Peters Wilson, professor of zoology at the University of North California, an authority on sponges and the lower vertebrates. The following foreign associates have been elected: Paul Sabatier, professor of chemistry, University of Toulouse, known for his work on metallic catalysts; Godfrey Harold Hardy, Savilian professor of geometry at the University of Oxford, and Carl Stumpf, emeritus professor of philosophy at the University of Berlin, originator of a new theory of sound and music.

SIR RICHARD GLAZEBROOK has been appointed, by Order of Council dated May 26, to be a member of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research.

SIR DANIEL HALL retired on June 4 from the post of Director-General of the Intelligence Department of the Ministry of Agriculture, which he has held since 1920. Sir Daniel will continue to act as Chief Scientific Adviser and chairman of the Research Council of the Ministry.

MR. H. C. SAMPSON, who was recently appointed economic botanist at the Royal Botanic Gardens, Kew, is leaving on June 11 for British Guiana at the invitation of the Governor and under the auspices of the Colonial Office and Empire Marketing Board, to study and report on various agricultural matters in the colony. He will also visit Trinidad and the Imperial College of Tropical Agriculture, and Barbados.

THERE have already been published, through De Gruyter of Berlin, two volumes of the *Vorgeschichtliches Jahrbuch*, dealing with the literature for 1924–1925. Owing to the sudden death of the collaborator for Great Britain and Ireland, the report on the literature of prehistoric archæology issued in those countries during 1926 has been undertaken by Dr. A. Mahr, Naturhistorisches Museum, Burgring 7, Wien 1, Austria, and to him all relevant publications should be sent, either as a gift or on loan, at the earliest date possible.

AT the anniversary meeting of the Linnean Society of London, held at Burlington House on May 24, the following were elected officers of the Society for 1927-28: *President*, Sir Sidney F. Harmer; *Treasurer*, Mr. H. W. Monckton; *Zoological Secretary*, Dr. W. T. Calman; *Botanical Secretary*, Mr. J. Ramsbottom. The Linnean Gold Medal was presented to Dr. Otto Stapf in recognition of his contributions to the advancement of botanical science. The Crisp Award and Medal were given to Dr. H. Graham Cannon, professor of zoology at the University of Sheffield, for his paper "On the Post-Embryonic Development of the Fairy Shrimp," published in the Society's journal.

WE have received the fourth number of *Brighter Biochemistry*, the illustrated journal of the Biochemical Laboratory, Sir William Dunn Institute, Cambridge. It fully maintains the reputation of its predecessors in dealing with the lighter, but not always apparently the brighter, sides of this science. Opportunity is taken to publish a First Depression from the Sir William Dunn Academy, in which a now famous portrait is but faintly disguised. New features are Researchers' Fables and an account of a visit to the twelfth International Congress of Physiology at Stockholm. For the rest, poems—or had we better say rhymes—and short 'scientific' articles amuse the reader, and can be enjoyed by any one for the moderate price of half a crown, payable to the editors at the Sir William Dunn Institute.

THE Swiss Society of Natural Sciences is holding its annual meeting this year on Sept. 1-4 at Basel. This will be the hundred and eighth session of the Society and the seventh occasion on which it has met in Basel. The general programme includes the opening address by the president, Dr. Fritz Sarasin, on Sept. 1, followed by a lecture by Prof. A. Brachet (Brussels) on the causes and factors of morphogenesis; other lectures will be given by Prof. L. Courvoisier (Berlin) on recent work and views in astronomy, by Prof. L. Duparc (Geneva) on the Urals from the point of view of geophysics, geology, and mining, and by Prof. H. E. Sigerist (Leipzig) on Paracelsus in relation to modern thought. The general work of the meeting will be divided among fourteen sections covering various aspects of science, communications for which should be received before June 30. All correspondence regarding the meeting should be addressed to Dr. Fritz Sarasin, 22 Spitalstrasse, Bâle.

THE series of postcards issued by the British Museum (Natural History) has received an interesting and attractive addition in the form of reproductions in colour of illustrations of medieval natural history from "Hortus Sanitatis," printed by Jacob Meydenbach at Mainz in 1491. Of particular interest are the drawings of mythological animals, such as the tyras, draconopede, sea horse, maricomorion, onocenthaurus and crasius, where the artist has had to rely on his own imagination, aided by the writings of classical mythology. The illustrations of animals such as the hippopotamus, chameleon, cameloleopard and the great ant, which the artist had never seen but had drawn from some traveller's description, are extraordinarily fascinating in their quaintness. The whole series is one of remarkable interest, and it is to be hoped that further additions will speedily follow. The illustrations are very clearly and pleasingly reproduced, and well maintain the excellent standard of the coloured postcards already issued by the Museum.

THE first number of *The Countryman*, a new illustrated quarterly review and miscellany of rural life, edited and published by J. W. Robertson Scott at Idbury, Kingham, Oxford, appeared in April last. It is a periodical concerned with the welfare of the men and women who live on the land and their cultivation, and has as its object the provision of brisk, timely, and authoritative articles, together with skilful and appetising digests of that practical information in every department of rural welfare which is at present scattered in books, journals, and papers. It is non-party in character and is intended to be of equal interest to men and women, and to help stimulate their efforts in the improvement of rural conditions, whether their activities are concerned with the problems of education, housing, village clubs or women's institutes, etc. Amongst the varied articles in the first number are the following: "Countryman Conversations," "The Trees we might have," "Is the Farmer Dead Beat?" "Aerials for Arable," "The Genteel Cottage," and "New Rural Tales," while authors include Sir Daniel Hall, Sir Francis Acland, Mr. Noel Buxton, and Sir Charles Bright. A special treatment of country books is promised for the second number.

The third issue of the *Journal of the Royal Technical College*, Glasgow, bearing the date December 1926, is a handsome production, and affords evidence of the activity of members of the College in research. The contents range over the fields of chemistry, physics, engineering, metallurgy, and bacteriology. An important paper by A. D. Third deals with compression losses in nozzles, the method used being that of photographing through the parallel glass sides of a diverging nozzle, the faces of which have been coated with a layer of a very viscous oil, which is thinned or swept away by the jet of air. A. S. Clark describes experiments to determine the relation between rapid tensile tests of metals at high temperatures and their creep limits, whilst O. Sneeden has determined the efficiency of arrangements for preheating air for furnace combustion. J. H. Andrew suggests an explanation of the fact that overheated mild steel usually appears on microscopical examination to contain more than its actual amount of carbon, and R. Hay and R. Higgins make a further contribution to the vexed question of the relations between austenite and martensite in hardened steels. The chemical papers deal with double salt formation, the induline dyestuffs, and the activity theory of solution, as well as with the preparation of a number of organic compounds. A curious photo-electric phenomenon observed by J. B. Somerville on steel surfaces suggests further investigation. There are other contributions of considerable scientific interest.

The annual report for 1925–26 of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington has recently been published. The non-magnetic ship *Carnegie* was out of commission during the year, and such ocean work as was done was due to Amundsen's ship *Maud*, which is associated with the Department in its magnetic work. Land survey work was also mainly in abeyance, though two survey parties were at work in Africa and America. The Department now maintains two magnetic observatories, in Western Australia and in Peru, and co-operates in the electric work of the Samoa Observatory. Vol. 5 of the Researches of the Department, dealing with the ocean work of the *Carnegie* from 1915 until 1921, was published during the year, and progress was made in the reduction of other observations made in various regions, to be published in vols. 6 and 7. The Department co-operated with the Geophysical Laboratory of the Institution in an important research upon the effect of high pressures on the magnetisability of nickel, meteoric and other kinds of iron; the high pressures are found to reduce the critical temperature, and the research seems to preclude the possibility that the earth's magnetism is due to permanent magnetisation of the interior. The Department has co-operated in radio investigation of the high-level conducting layer of the atmosphere, and members of its staff have also made researches on problems of atomic physics.

Three catalogues of second-hand books, maps, etc., numbered respectively 495, 496, and 497, have recently reached us from Mr. F. Edwards, 83A High Street, Marylebone, W.1. They deal with publications concerning "The West Indies," "London and its Environs," and "The Indian Empire." Copies can be had free from the publisher upon application.

Mr. James Thin, 54 South Bridge, Edinburgh, has just issued a very full list (No. 215) of books dealing with natural history subjects. Upwards of 2700 works are catalogued under the headings of agriculture and husbandry, bees and bee-keeping, botany, entomology, ferns, forestry, fruit culture, fungi, gardening, geology and palæontology, grasses, marine and fresh-water zoology, mosses, natural history (local and general), and ornithology. The catalogue is obtainable free upon request.

The course of lectures on "The Mind" which was delivered this year at King's College, London, by various authors, is to be published by Messrs. Longmans and Co., Ltd. The subjects and contributors are as follow: Biology, Prof. J. S. Huxley; Physiology, Prof. R. J. S. McDowall; Psychology, Dr. F. A. P. Aveling; Psychotherapy, Dr. J. A. Hadfield; Physics, Prof. F. A. Lindemann; Philosophy, Dr. W. R. Matthews; Education, Prof. J. D. Wilson; Æsthetics, R. G. Collingwood; Anthropology, Prof. C. G. Seligman; and Sociology, Prof. L. T. Hobhouse.

Applications are invited for the following appointments, on or before the dates mentioned:—A lecturer in engineering and a lecturer in chemistry and physics at Stockport College for Further Education—The Principal (June 17). A vice-principal of the Somerset Farm Institute, Cannington—The Principal, Somerset Farm Institute, Cannington, near Bridgwater (June 20). An assistant pathological chemist at St. Mary's Hospital, Paddington—The Secretary, St. Mary's Hospital, W.2 (June 20). A part-time demonstrator in geology at Bedford College for Women—The Secretary, Bedford College for Women, Regent's Park, N.W.1 (June 24). A full-time lecturer in mathematics and science in the School of Science and Art, Newark—The Principal, School of Science and Art, London Road, Newark-on-Trent (June 25). A vice-principal of the Royal Agricultural College, Cirencester—Dr. J. A. Hanley, The University, Bristol (June 25). A professor of technological chemistry in the Manchester Municipal College of Technology—The Registrar, Municipal College of Technology, Manchester (June 28). An assistant professor of metallurgy at University College of Swansea—The Registrar, University College, Swansea (July 2). A biochemist and a bacteriologist at the National Institute for Research in Dairying—The Secretary, National Institute for Research in Dairying, Shinfield, near Reading.

Research Items.

Madi Rainstones.—Mr. F. H. Rogers contributes to *Man* for May some valuable notes on rainstones in three areas in East Africa—Meturu, near Dufile, on the Nile, Metuh and Laropi, also near Dufile. In Meturu there are two sets of these stones; one, of four stones, is said to have been brought from the Bari country by Moyi when flying from a jealous brother—the present chief is sixth in succession from Moyi. As there was a good deal of rain when Moyi arrived, he gave out that it was on account of these stones. The second set of stones consists of ten, which have been found from time to time during the reign of the present chief. They also are much venerated. On account of their special shape and smoothness they are considered to have been moulded by God. The stones are kept in a pot and nominally are in charge of the chief, but as they may be handled safely only by boys and old men, he usually deputes some one else to guard them and carry out the rain-making ceremonies. At present the guardian is the chief's mother. If the government has found it necessary to appoint a reigning chief from another family, the custody of the stones still remains in the hereditary rain-making family. When the rains fail, a meeting is called under the *rudu* or sacred tree, a bull is killed and eaten, and a general request for the rain-making ceremony is put forward, when the custodian is instructed accordingly. The custodian then kills a black sheep and anoints a young member of the family, who is under instruction, on the forehead, chest, back of the hands, and dorsum of the feet, with fat from the kidneys. He is then sent to fetch water from the River Areze, with which the stones are carefully washed, first separately, then in the pot. They and the pot are then smeared with fat and put away after the remainder of the water has been poured on them. The boy then goes to sleep for the night, lying prone on his face to ensure an equal distribution of rain over the whole country.

The Physique of Filipinos.—In the *Philippine Journal of Science* for March, Juan C. Nañagas and Leon C. Santiago have analysed measurements of 713 university students, of whom 564 are male and 149 female. These measurements were not made by the authors themselves, and though both sets present certain deficiencies, those of the female students are in particular especially defective, and can scarcely, for the most part, be regarded as significant for the authors' purpose. The coefficient of variation in each group of measurement is such that the groups cannot be regarded as homogeneous. This is as might be expected, as the regional distribution of the students is wide and there is considerable blood intermixture, ranging from Filipinos of pure Malay type to those of near or distant Chinese and Spanish lineage, as well as hybrids of the various constituent elements of the population. The measurements here analysed are stature, weight with the derivative indication of build, and vital capacity, chest circumference, and the derivative index of constitution or robustness. The figures for the Filipinos are compared with university students of Great Britain and the United States where these are available, and the military measurements of Europeans, United States, and Mongolians—North and South China—Korea, and Japan; also Siamese civilians. In stature the Filipinos correspond with the South Chinese group, the measurements being Filipinos 163·3, South China 163·1, but in all the other measurements they show a surprising deficiency, both proportionate and absolute. The authors regard this as an indication of serious underdevelopment and malnutrition among the students, and, as they may be regarded as a select class, of a still more serious condition among the average of the inhabitants. The figures relating to the female students, notwithstanding their defects, point even more emphatically in the same direction.

Biological Studies at the Tortugas.—An interesting summary of the work carried out at the Tortugas Laboratory during the summer of 1926 is contained in Year Book No. 25, 1925-26, of the Carnegie Institution of Washington. Investigations were conducted by eleven workers, Dr. W. H. Longley acting as administrative officer for the season. Floristic studies, both on algæ and diatoms, were carried out, and the fauna, especially in the case of fish and amphipods, was further investigated. Dr. Paul Bartsch continued breeding experiments on cerions, while a series of interesting experimental studies were carried out by other workers. These included experiments on the electrical conductivity in the alga, Valonia; on the behaviour of trematode larvæ; on the organisation of echinoderm eggs; and on regeneration in the starfish, Linckia. Working with the micro-manipulation apparatus designed by himself, Dr. C. V. Taylor, together with D. H. Tennent and D. M. Whitaker, found, as a result of work on the eggs of *Lytechinis variegatus*, that, in opposition to Boveri's classic observations, there is no localisation of micromere-forming material nor any evidence that this substance has been differentiated before fertilisation. They found evidence, however, of the differentiation of ectoderm-forming substance over the entire surface of the egg even before fertilisation, the endoderm substance being excluded from the superficial layers of the egg. J. M. Valentine's work on regeneration in Linckia revealed a number of interesting points, notably that, though autotomised arms in this genus can regenerate an entire animal, this did not occur after isolated arms had been cut off, also that the latent period before the beginning of regeneration, where an arm only was concerned, was about a third of that necessary when a part of the disc was involved. Where arms were amputated at various levels the buds which developed nearest the disc grew most quickly.

A Parasite of the Greenhouse White-Fly.—In the *Bulletin of Entomological Research*, vol. 17, Part 3, March 1927, Mr. E. R. Speyer, of the Cheshunt Research Station, gives an account of the life-history of a small chalcid, *Encarsia formosa*, which parasitises the common greenhouse white-fly. It appears that an individual female Encarsia may lay its eggs in the pupæ of fifty or more of its host. The parasitic larvæ that emerge from these eggs destroy the white-fly pupæ: the skins of the latter become black, and this feature distinguishes the parasitised pupæ from normal white scales and pupæ. The parasite thrives best at high temperatures and is probably a tropical insect possibly imported into Great Britain from India. It is noteworthy that fumigation with hydrocyanic acid gas as practised commercially for the control of the white-fly is stated to leave the parasites unaffected. Whether this insect can be utilised as an auxiliary method of controlling the white-fly it would be premature to decide, as the author mentions, for example, that it is uncertain how it passes the winter, if indeed it is able to do so in Great Britain, without artificial heat. The species is parthenogenetic, males are scarce, and have so far only been found under conditions that were preceded by low temperatures in September and October. In a glasshouse that was specially heated over the same periods, no males could be found. It appears probable, as in some other chalcids, that males play an insignificant rôle in the economy of the species and that habitual parthenogenesis prevails. This latter feature is an advantage from the economic point of view, in that pairing has not been arranged for and the insect evidently reproduces freely and would require comparatively little attention.

The Cotton Plant.—M. A. Bailey and T. Trought, of the Egyptian Ministry of Agriculture, working along the analytical lines first introduced by Dr. W. Lawrence Balls, have made some considerable contribution to our knowledge of the development of the cotton plant (Technical and Scientific Series Bulletin, No. 60, Ministry of Agriculture of Egypt). They adduce evidence to show that the normal period of development of a flower bud of cotton in Egypt is not less than 42 days, and the period required for boll development about 52 days. The development of the sympodial flowering branch is traced from an early stage, and it is shown that the four succeeding internodes are laid down before the first internode has reached its final length. The existence of regular flowering intervals in Egyptian cotton plants is demonstrated, and the intervals are shown to be of a similar order to those found by Harlan in the case of Sea Island cotton. Balls has directed attention to the fact that the daily flowering curves for a group of plants exhibit marked fluctuations from day to day, and further, that the curves for two different crops of cotton grown apart often exhibit a marked concordance in their fluctuations, to explain which he suggests some fluctuating environmental factor with a wide range of influence, *e.g.* day and night temperatures obtaining at commencement of flower-bud development. The present authors are unable to confirm this suggestion, and data are given to show that the minimum temperatures which occur when the bud primordia are being differentiated have no effect on the length of the interval between the flowers which open about 42 days later. They conclude from their evidence that flower-bud shedding is not only the principal factor affecting the fluctuations of average flowering curves, but also one of the most important factors affecting the yield of cotton in Egypt at the present time. A further paper on the nature and effect of bud shedding is promised.

Chromosomes of Pigeons.—A study of the chromosomes of the pigeon, by Mr. Kan Oguma (*Jour. Coll. Agric. Hokkaido Imp. Univ.*, Sapporo, Japan, vol. 16, part 6), yields some interesting results. In counting the chromosomes from seven embryos belonging to four clutches of eggs, four embryos had 61 chromosomes and three 62, including in each case six very minute pairs. The unpaired or X-chromosome is a large one. In the spermatogonia of adult males, 62 chromosomes were counted, including two (XX) of the maximum size. These numbers are much higher than those found in early studies of the pigeon, in which the chromosomes were lumped through insufficient fixation. Also there is no evidence of a double reduction division, as reported by Guyer. These chromosome conditions indicate that the female is the heterozygous sex, which is in harmony with the genetic evidence for birds. It has long been held that each clutch of eggs in the pigeon produces one male and one female, but in 50 clutches examined both eggs were of the same sex as often as they were of different sexes. Contrary to the description of the chromosomes of fowls by Hance, no fragmentation of chromosomes is found in the pigeon. Similarities between the chromosome groups of birds and reptiles (lizards) have been pointed out, each having both macro- and micro-chromosomes; but birds have also some chromosomes of intermediate size.

Sugar Beet.—The fourth Rothamsted Conference (London: Ernest Benn, Ltd., 1927) deals with the culture and manuring of sugar beet. Some account of continental practice is given, which though of great value to the English farmer, must be thoroughly tested under local conditions before it can be used to full advantage. The yield of beets in England is at present unsatisfactory though the quality is good, but under existing terms of contract the total yield is of greater importance provided both conditions cannot be realised simultaneously. The methods of cultivation of the crop require much further experimental work. The question of manurial treatment is less urgent, though the latter has yet to be correlated with the varied conditions of soil and climate in Britain. The suitability of climatic conditions for growing sugar beet in England seems indisputable, and points to the possibility of success for the industry.

Wood Pulp from Poplar.—Science Service has issued an illustrated popular account of recent experiments in crossing poplar trees to produce a rapidly growing hybrid tree for the production of wood pulp. Poplar gives a higher quality of paper than spruce, and the rapid depletion of forests for the production of wood pulp has led to this attempt to regenerate forests at a more rapid rate. Hybrid vigour is a well-known fact, observed by Darwin. Although the cause remains somewhat obscure, certain hybrid walnuts have long been known to grow at a rapid rate, and the best of these hybrid poplars are said to be capable of growing to a diameter of 18 inches in 18 years and yielding 100 cords of wood to the acre. There will be plenty of need for them, as the United States consumed a total of 5,565,831 tons of wood pulp in 1925. Once produced, the hybrids can readily be multiplied by cuttings, since they root as readily as willows. This is probably the first attempt to increase wood production by breeding methods, and it may lead to large results.

New Species of Mollusca in the United States National Museum.—The veteran Dr. Dall (now, alas, deceased), in continuation of similar work on the same lines, publishes some diagnoses of undescribed new species of mollusca in the collection of the United States National Museum. The shells dealt with belong to the Scaphopoda, Gastropoda, and Polyplacophora. Unfortunately the descriptions are not accompanied by figures, which would have added to the value of the paper.

Earthquakes and the Tilting of the Ground.—For some years before the Japanese earthquake of 1923, mareograph records revealed a continuous depression of the coast of Sagami Bay. This was succeeded by a period of repose, and then came the great earthquake and with it a marked elevation of the coast (Nature, vol. 119, p. 254). Led by these observations, Mr. M. Ishimoto erected a pair of horizontal pendulums of the Zollner type in a cellar of the Imperial University of Tokyo in order to determine if any tilting occurred before or after earthquakes. He has recently published a preliminary paper on the observations made last summer (*Bulletin of the Earthquake Research Institute*, Tokyo, vol. 2, 1927, pp. 1-12). The principal change of inclination is diurnal, and closely follows the change of air-temperature. When distant earthquakes occur, the instrument shows no change of inclination. But after some near earthquakes the record shows a slight change, either of elevation or depression, in the direction of the epicentres. One observation may prove of considerable interest. On Aug. 3 a strong earthquake occurred with its epicentre in Tokyo Bay and 33 miles south of Tokyo. Two weeks before, there was an anomaly in the N.-S. component independent of the diurnal variation. Just before the earthquake, the pendulum indicated no change. After it, the record was lost owing to the fracture of the suspending quartz-fibres.

INTERFERENCE OF RADIO-WAVES.—In the *Zeitschrift fur Hochfrequenztechnik* of December last, E. Quäck discusses the interference which is produced when using high-frequency radio-waves, by the waves which have travelled one way round the earth with those that have travelled the other way. In the short-wave radio-messages sent last October between America and Berlin, the signals recorded on the tape were often mutilated in such a way as to suggest an interference of this kind. The Telefunken Company investigated the phenomena and proved conclusively that the waves did travel round the world in opposite directions. Assuming that the velocity of the waves is the same as that of light—3×10^{10} cm. per second—the difference between the lengths of the paths of the two waves comes out to about 28,800 kilometres, the time lag being 0·096 of a second. In another experiment a signal transmitted from Nauen on a wave-length of 15 metres was received at the neighbouring town of Geltow. The first signal came directly over a few kilometres; the second was given by the waves which had travelled round the world. The time lag between them showed that if the waves had travelled with the velocity of light at a height of 182 kilometres above the earth's surface, the time difference between the arrivals of the signal would have been the same. It is curious that this so-called 'echo' effect has only been observed when using wave-lengths lying between 15 metres and 22 metres. Further investigation of this phenomenon may throw light on the method of the propagation of the waves through the upper atmosphere.

PIEZO-ELECTRICITY OF QUARTZ.—A new investigation by L. H. Dawson of the piezo-electric properties of crystalline quartz has brought to light a number of fresh facts (*Physical Review*, 29, p. 532; 1927). When a parallelopiped cut with an electric axis normal to a large face was explored, it was found that the local charges developed varied from point to point both in magnitude and sign, but the irregularities were of a permanent nature, surviving, for example, temporary transition to the β modification. The accepted Curie constant is only an average value when large areas are employed. The curved surface of a cylinder the end of which was parallel to the plane of the electric axes showed three positive areas and three negative areas, spaced symmetrically, providing a way of finding the electric axes when only the optic axis was known. When the temperature was varied, the piezo-electric effect passed through a maximum at 60° C., and the cooling curves showed a lag. All the crystals were cut under exceptionally good conditions, and appeared free from flaws when examined optically. The results seem to be consistent with the idea that large crystals are not perfectly formed, for which there is independent evidence from X-ray analysis, but the author considers that it will be difficult to account for them completely with the present knowledge of the molecular structure of quartz.

COMPUTING MACHINES.—Computing machines of various kinds have become part of the normal equipment of most scientific departments and large business firms. It is of especial interest, therefore, to examine the relative merits of these machines. In a lecture delivered under the auspices of the Office Machinery Users' Association on Feb. 15, Dr. L. J. Comrie performs this useful function. According to him the ideal machine should perform all the operations with equal facility (adding or listing machines merely, are deficient in this respect), and the result should be visible immediately on completion of the operation. The keyboard should be uniform to touch for all numbers, and should not allow two keys to lock simultaneously. Moreover, it should not be necessary to reverse a special lever for subtraction, or, as in the case of most arithmometers, should the carriage require to be lifted at any stage; there should be tens transmission throughout the multiplier and product registers, and it should have a sight dial. A number of other important points are dealt with and the various machines are classified according to whether or not they possess these characteristics. In the case of the hand-operated barrel-type machine, Dr. Comrie holds that the Nova Brunsviga stands out above the others, but with the electrically operated machine the case is not so clear. Dr. Comrie evidently in his merit classification has in mind the use of such a machine in a department where every second saved in the computation is of importance. While this is so in large insurance offices, and even in statistical and mathematical laboratories, the ordinary scientific worker is not so pressed usually that he requires to consider a minute or so gained on a long calculation. Where the machine is to undergo strenuous operation of the type contemplated, the life of the machine, wear and tear and elastic fatigue become important considerations. These factors do not appear to have been dealt with by the lecturer.

FLAME MOVEMENT.—Among the large amount of work carried out by the Safety in Mines Research Board, one of the most important subjects is the study of the propagation of flame in closed vessels. Paper No. 32, published by H.M. Stationery Office (1*s*. net), by O. C. de C. Ellis, contains a summary of the principal methods used in the study of flame movement. Although the earlier methods enabled the speed of the flame to be measured, it was not until the method of snapshot photography had been devised that a close determination of the mode of propagation could be made. This method is fully described in the paper, and is illustrated by means of a number of excellent plates.

ANALYSIS OF COAL.—We have received a copy of the report on the methods of analysis of coal which has been prepared by the Fuel Research Division of the Department of Scientific and Industrial Research. The methods which this report (London: H.M. Stationery Office, 1927. 9*d*. net) describes have been adopted by the Research Department for the purpose of its work on coal, and it is hoped that they will be adopted generally by analysts throughout Great Britain so that all results of coal research may be strictly comparable. The paper contains detailed information with regard to the analysis, and the determination of the caking index and the calorific value of a given sample of coal. Two methods of carbonisation assay are described, and an example illustrating the form in which an analysis should be reported is included.

The New Science School at Clifton College.

In the development of the teaching of natural science in schools, Clifton College has, from the earliest days, played a very important part. Fortunate in possessing a succession of sympathetic headmasters, and in securing the services of men like Debus, Worthington, Sir William Tilden, Shenstone, and Rintoul, Clifton rapidly acquired a reputation for sound scientific education, and exerted a powerful influence upon contemporary educational practice. Laboratories were built and well equipped, and there was a constant stream of visitors to see what were then the latest developments of the new movement.

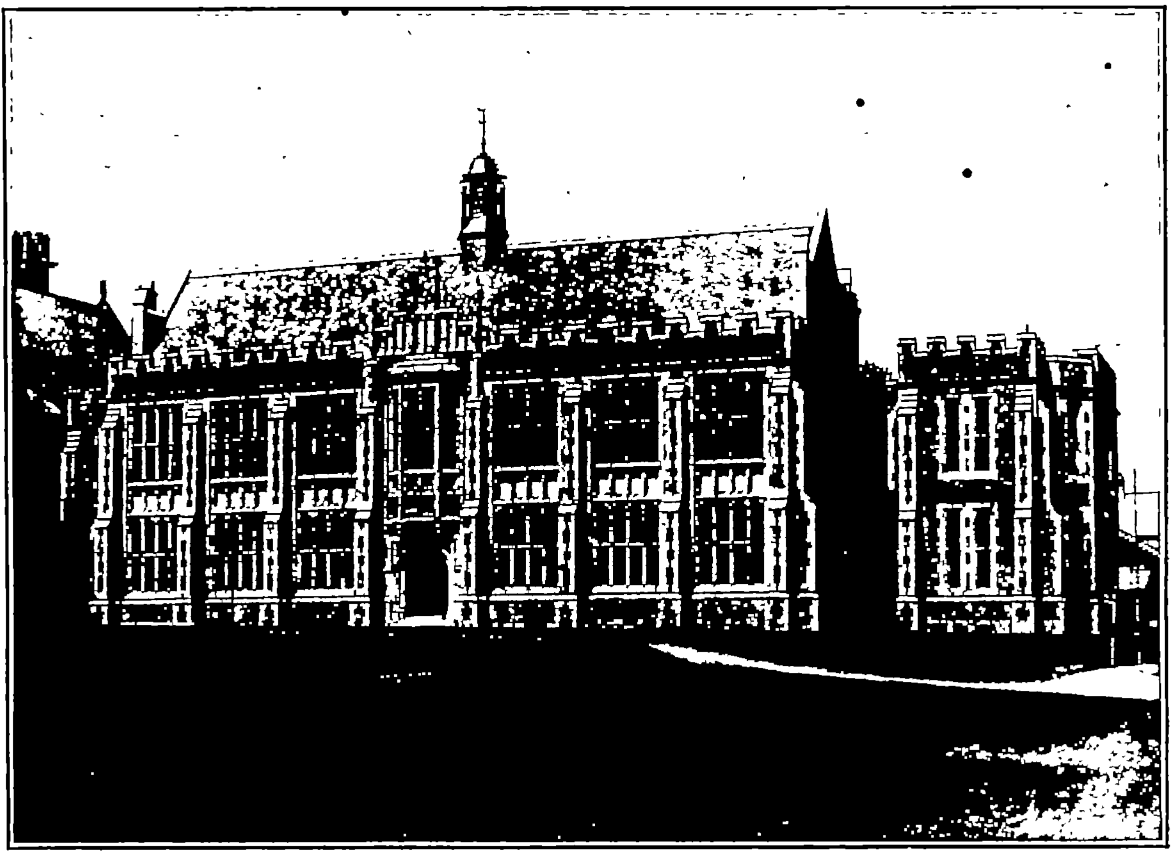

Fig. 1.—The new Science School, Clifton College.

At this time the College far out-distanced other schools in accommodation for science teaching, but, like many other pioneers, it has since been left behind by those to whom it pointed the way. Some expansions and improvements were made from time to time, but finally the buildings became so much out-of-date and inadequate to the needs of the school that new and extensive premises were a necessity. When, thanks to the initiative of Mr. Norman Whatley, the present headmaster, the problem was at length seriously taken in hand, it was resolved to erect an entirely new science block, worthy of the tradition of the school, and one, too, which should restore to Clifton its former position in the van. Old Cliftonians responded generously to the call for funds, and sufficient was soon forthcoming to allow the council to proceed with the scheme. A stroke of good fortune came at once, in that it proved possible to secure the services as architect of Mr. Alan E. Munby, whose genius in this particular *genre* is well known to scientific workers. The total cost of the scheme is estimated at £50,000; and Mr. Whatley was able to announce at the opening of the building by the Prince of Wales on June 2 that four-fifths of this amount, or £40,000, had already been given. This satisfactory result is due almost entirely to the unaided efforts of the Right Hon. J. H. Whitley, Speaker of the House of Commons, who has interested himself personally in the scheme from the outset.

The new buildings are the outcome of a number of alternative designs. The preservation of the Close for games was regarded as all-important, and this accounts for the somewhat recessed position of the buildings, which cover a considerable ground area. The frontage to the Close is shown in Fig. 1. Few modern science buildings are erected in the Gothic style, but in this instance it was felt that the architectural surroundings of the College left no possible alternative, and by the adoption of a late period in this style, the difficulty of securing the ample natural light necessary has been met satisfactorily. Bath-stone has been employed, with local stone for general walling, as used in other college buildings.

The design comprises two principal floors with a partial basement and partial second storey. The extreme length of the building is some 160 ft. and the breadth about 64 ft. As shown on the plan (Fig. 2), there is a central block, which contains the laboratories and their adjuncts, with two wings of two storeys only, devoted to four lecture-rooms. This plan illustrates the first (chemistry) floor, as presenting more technical details than the ground floor, the plan of which is similar.

PHYSICS.

The old accommodation consists of one laboratory and two lecture-rooms. The latter will just suffice—with difficulty—for the theoretical classes, but the laboratory and storage places are greatly overcrowded. Classes much too large, for the laboratory follow one another continuously, so that the distribution and collection of apparatus seriously curtail the short time available for work, and no experiment can be left set up to be finished later. The school is well equipped with apparatus for this single physical laboratory, but lack of space and the vibration of the floor render the use of the more delicate instruments practically impossible. In the new Science School, the ground floor is devoted to physics, and comprises two elementary laboratories on the frontage, 40 ft. by 32 ft., on either side of the central entrance. The latter gives access to a corridor, at the ends of which are the two lecture-rooms with preparation rooms attached. Separate external approach to the preparation rooms is given by doors to the corridor terminations. On the other side of the corridor are, on the right, an advanced laboratory, 37 ft. by 20 ft., with adjoining store, and on the left of the central staircase a repair workshop 17 ft. by 20 ft., and a master's room 19 ft. by 20 ft. A research room and a photographic dark-room are also provided on this floor.

The two elementary laboratories are well lighted, and are spaced to give accommodation for classes of 30-36; they are large enough to store the necessary apparatus so that it is properly protected and easy to distribute. The apparatus drawers are uniform in size with those of the main physical store-room, so that a complete change of apparatus for each term's work may be effected with the minimum trouble and in a very short time. The benches are fixed, as the rooms will be used for large classes for short periods.

The laboratory for advanced work has been carefully designed to meet the requirements of higher certificate and university scholarship candidates. It has movable tables, to render it more elastic, and the water, gas, and electric current are brought to convenient points on the walls. The adjoining store-room can be darkened for use as an optical room. All the working rooms are provided with gas, water, and steam supplies, and, as is necessary in the teaching of modern physics, liberal electrical supplies, including main and low-voltage alternating current, and direct current distributed from a battery in the basement by a switchboard specially designed to give to each room separately a full range of voltages with equal distribution of loads among the cells of the battery. All pipes and other bench fittings are non-magnetic. Firm supports to carry heavy mechanical apparatus have been built into the walls and ceilings at convenient places. The flooring of the whole of the physics section is of maple blocks on concrete, to ensure complete absence of vibration.

CHEMISTRY.

The first floor (illustrated in Fig. 2) is devoted mainly to chemistry, but there is also a biological laboratory designed to accommodate 15 to 20 boys. In the general arrangement of the lecture-rooms advanced laboratory and elementary laboratories, this floor resembles the one below. The space occupied on the ground floor by the entrance hall is, however, usefully employed on the chemistry floor in providing a balance room and dispensary, common to both elementary laboratories. The dispensary, in which laboratory assistants are constantly on duty, serves as a distribution room and store for common apparatus.

The lecture-rooms will each hold sixty boys with ease and comfort; the average sets are of course only about half this size, but a large lecture-room enables two sets to be taken together upon special occasions such as lantern lectures or particular topics, and will also accommodate sectional meetings of the scientific society. Large lecture-rooms are also much pleasanter, in that the atmosphere of a small room, however efficiently ventilated, may become distinctly unfitted for boys during lectures on chlorine, phosphine, etc. In planning school laboratories and science rooms, too little consideration is often given to the fact that young people

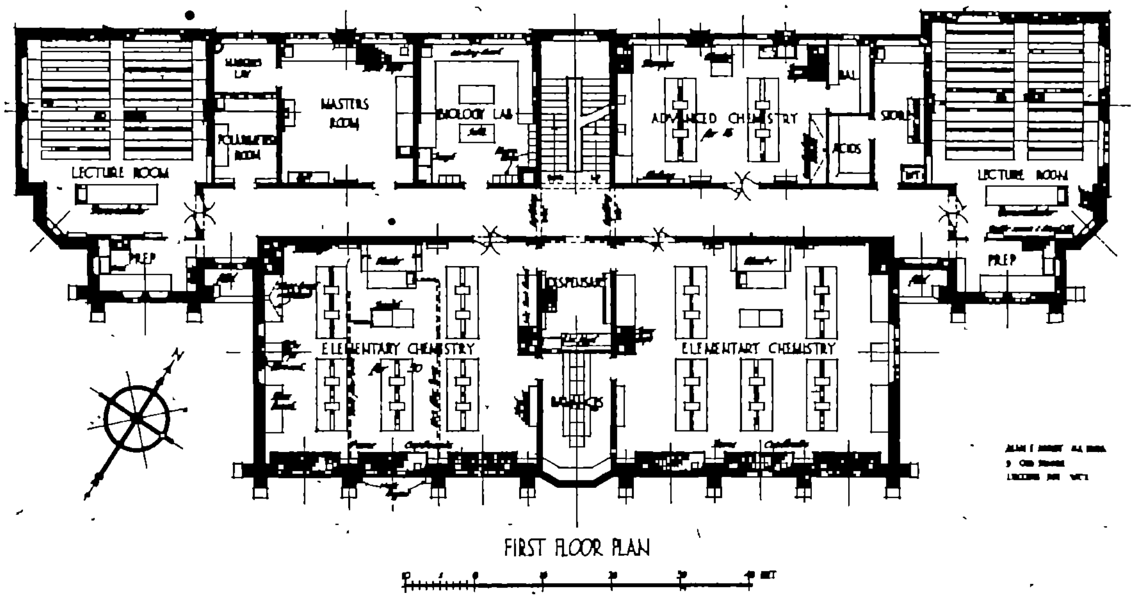

FIG. 2.—Plan of first floor of new Science School, Clifton College.

are in general much more sensitive to fumes, poisonous gases, and other similar effluvia, than are many adults.

This important point has been borne in mind in the design of the elementary laboratories, where sufficient fume-cupboards have been erected (mainly along the windows) to provide for the whole class when working upon unpleasant substances. The cupboards are themselves efficiently ventilated, so that it is hoped that the air of the laboratories may remain fresh even in the most adverse circumstances.

In the balance-room the balances are enclosed in special cases built as part of the fittings. They are placed on stable benches, which are wide enough to take open exercise books immediately in front of the balances.

The advanced laboratory will provide good working accommodation for twenty boys. A stone slab, covered by an asbestos hood, will be used for combustions and similar work, while a Carius cupboard, fitted with concrete floor, tiled sides, sliding steel door and an interior light, is built under one of the fume-cupboards. A separate balance-room is attached to the laboratory. Steam, gas, electricity, and water are laid on to this as to all other working rooms. One feature worthy of special note is that all filter-pumps are worked, not from the general laboratory circuit, but from a separate main communicating with the town main in the adjoining road.

Biology.

At present, biology is taught mainly in the junior school and the lower forms of the senior school; the biological laboratory in the new building is a small room (to hold eighteen or so) for the accommodation of the class of First M.B. candidates. Should further space be required for biology in the future, a large room on the second floor, to be used temporarily for physical geography, has been built in such a way that its conversion to a biological laboratory could be carried out with very little difficulty or expense.

The chemistry floor includes, in addition to the rooms already mentioned, a polarimeter room and a room—partly office, partly private laboratory—for the head of the science department. By reducing the corridor height on this floor some cross lighting and ventilation has been made possible.

The Science Library.

The most attractive room in the building is the library, on the second floor. A large and airy room, it is floored and fitted throughout in oak. It may, perhaps, be claimed without exaggeration that the emphasis now laid in schools upon the humanistic aspect of science has been largely due to Clifton influence; and it is therefore not surprising to find that the science library at the College includes a rich selection of classical scientific books and memoirs, which will at length find a home worthy of them.

The Royal Observatory, Greenwich.

Annual Visitation.

The annual visitation of the Royal Observatory took place on the afternoon of Friday, June 3; the usual Saturday date being changed owing to the Whitsun holiday.

The Astronomer Royal presented his report, which deals with the work of the observatory for the year ended May 10, 1927. The usual observations of the sun, moon, planets, and fundamental stars are being continued with the Transit Circle; also of stars brighter than mag. 8·0 between N. Decl. 32° and 64°, and the stars selected for comparison with Eros at the opposition of 1931. The corrections to Brown's Tables of the moon in 1926 were $+6{\cdot}5''$ in longitude, and $-0{\cdot}8''$ in latitude; they have been slowly diminishing since the Tables were first used, in 1923. Mr. Cullen has made a redetermination of the declinations and proper motions of the brighter stars, from observations made with the instrument during the whole interval since its erection in 1850. He finds for the correction to Boss $+0{\cdot}33'' + 0{\cdot}0068'' (t - 1925{\cdot}0)$.

The Altazimuth has also been used in recent years to find the correction to Boss's declinations from observations in the Prime Vertical; the values found are $+0{\cdot}20''$, $+0{\cdot}44''$, $+0{\cdot}45''$, $+0{\cdot}51''$ at declinations 45°, 35°, 25°, 15° respectively. These are intermediate between the values given by Raymond and Eichelberger.

The Cookson Floating Telescope has been borrowed from the Observatory of Cambridge for a third period of seven years; it is used for determining latitude variation and the constant of aberration. The reductions for the second seven years are nearly completed.

Fourteen completed determinations of stellar parallax have been made during the year with the 26-inch refractor, bringing the total up to 330.

The 30-inch reflector has been used for a determination of the effective temperatures of stars of early type; the results for twenty-two stars have recently been published in the *Mon. Not. R.A.S.* The instrument has also been used by Mr. Merton for photographing comets Comas Sola, Stearns, Pons-Winnecke, and Grigg-Skjellerup.

Plates are being taken with the Astrographic Equatorial for determining proper motions by comparison with those taken twenty-five to thirty years ago. The work is now nearly complete from declination 65° to 71°. Dr. H. Groot is also examining the astrographic plates for detecting double stars on them. He has found 187 pairs with separation less than 5 seconds in the zones 65° to 71°. Mr. Merton mounted two aeroplane lenses of 20 inches focus, working at F/5·6 on the tube of the astrographic telescope. These have proved very useful for photographing comets; it was with a similar lens that Mr. F. J. Hargreaves photographed comet Grigg-Skjellerup in advance of Harvard and Yerkes Observatories.

The sun was photographed on 251 days; most of the missing days are filled by photographs taken at the Cape or Kodaikanal; solar activity has been considerable, but with marked depressions at times. Between May and January there were ten naked-eye groups: but since January there have been no very large spots. Messrs. Ross have supplied new enlarging lenses for both the photoheliographs, which improve the definition at the sun's limb.

The late Mr. W. H. Wesley made drawings of the corona from the Greenwich expeditions' photographs of 1898, 1900, 1901, 1905; also from Mr. McClean's of 1908. Miss A. M. D. Crommelin made similar drawings of the eclipses of 1914, 1919. These have been reproduced in the *Philosophical Transactions*, Series A, vol. 22. Mr. Davidson and Col. Stratton have discussed the photographs obtained in Sumatra in 1926. The results will shortly appear in the *R.A.S. Memoirs*.

A party from the observatory will visit Giggleswick for the eclipse of June 29. The programme includes comparison of the intensities of certain calcium lines, the spectrum of the chromosphere from *D* to the extreme red, and direct photography of the corona. Mr. Greaves and Mr. Witchell are viewing the eclipse from an aeroplane.

The magnetic observations are now all made at Abinger; the mean values of the elements for 1926 are: Decl. W. 13° 10·4′; Hor. Force, 0·18581; Vert. Force, 0·42947; Dip, 66° 36·2′. Comparison of magnetic disturbances, as recorded at Greenwich and Abinger shows that the latter are smaller by about 3 per cent. The quinquennial revision of the Admiralty magnetic charts was carried out, and isogonals for 1927·5 adopted. After some necessary improvements in the insulation, the Schuster-Smith coil magnetometer was adopted as the standard from February last. A redetermination of the moment of inertia of Dr. W. Watson's standard cylinder gave a result identical with his value found in 1903; this cylinder is now adopted as a standard.

The following weather statistics are for the year ended on April 30. The average is that of the seventy-five years 1841–1915: Temperature 50·2°, being 0·6° above the average. Mean daily movement of the air, 284 miles, just the average value. Bright sunshine, 1320 hours, being 29·7 per cent. of possible amount. Rainfall, 28·20 inches, being 3·96 above average. The wettest month was November, 4·77 inches; the driest December, 0·38 inches.

Two standard sidereal clocks (Shortt Nos. 3 and 11) have been in use since July; during the last fifty days their rates have been nearly coincident, and the clocks have never differed by more than 0·05^{s}. A mean time clock of the Shortt type has been ordered, which will be used for the distribution of radio time-signals through the Rugby Station. Rhythmic signals will be sent at 10^{h} and 18^{h}.

The observatory took part in the radio longitude campaign last autumn. Advance copies of the time-determinations and the times of receipt of radio signals have been printed and circulated. The corrections to the adopted longitudes of Paris and Washington appear to be less than 0·02^{s}. The longitude of Pulkovo was determined by the Russian observers as 2^{h} 1^{m} 18·572^{s}.

Allusion is made in the report to Mr. G. Merton's researches on the comet Grigg-Skjellerup, published as an *R.A.S. Memoir*. The observed perihelion passage was earlier than the predicted time by 0·2 days.

Dr. A. C. D. Crommelin retired from the Observatory on May 10, after thirty-six years' service (see NATURE, May 28, p. 790).

South-Eastern Union of Scientific Societies.

ANNUAL CONGRESS.

THE thirty-second annual congress of the South-Eastern Union was held at St. Leonards-on-Sea on June 25-28, the president being Dr. A. B. Rendle, whose address was devoted to "The Flora of Sussex, Past and Present." The Wealden flora dates from the fourth continental period. Tree-ferns and other ferns comprise twenty-three out of the seventy species of Wealden plants known, a flora representing a moist, warm, and possibly tropical climate. In a paper by Dr. E. J. Salisbury it was shown that the plants that had become extinct in certain countries or had definitely diminished numbered 294, or about thirty per cent. of the total British flora, although speaking for the whole country those that had become actually extinct was surprisingly small. About eighteen or twenty seaside plants were disappearing, principally by indiscriminate picking of the flowers. Seakale was believed to have been first offered for sale at Covent Garden in 1875, and this came from Pevensey. Members were surprised at the quantity seen in flower on the beaches east of Hastings. The Mayor of Hastings, an enthusiastic botanist, read a paper of much interest on the "Weeds of a St. Leonards Garden."

In the Zoological Section Prof. E. W. MacBride gave an address on "The Origin and Nature of Mutations," a subject he has made peculiarly his own. He defined mutations as conspicuous deviations from type which occurred suddenly without obvious cause and were strongly inherited, most of them, however, being failures from the point of view of natural selection. Reference was made to Tornier's theory that abnormal variations are due to the environment in which the eggs were laid and fertilised. The effects of the weakening of the germ could be recognised in the characters of domestic breeds of wild animals. Evil conditions surrounding the egg rapidly produced mutations, and quickly as they come they as quickly go.

In a paper entitled "Territory in Bird-Life," Prof. C. Lloyd Morgan dealt with the habit of birds to separate from the flock in early spring to enter upon their territory period. Dealing particularly with the lapwings, he said that so long as the birds were in flocks the behaviour of all the male birds was much the same, and no marked hostility was shown, but directly they got into the territory phase hostilities broke out. If a cold snap came after a warm period, the males resorted to the flock-phase and all became perfectly friendly once more. When once a male had fixed his territory he sang his best to attract the females to his area, but the males were warned off, and their presence in his territory was resented. The female that joined him was just as jealous as he was. How the territory was defined is a subject for further examination, but evidently it was a directive factor of some sort.

In the Geological Section, Mr. H. B. Milner chose for his address "The Weald-Boulonnais Section of the English Channel," and with the assistance of carefully prepared plans showed the structure of the submarine ridges in the Channel area. With the help obtained from Admiralty charts he was able to show that the gravel and other banks arranged themselves in a remarkable manner on the lines of the Armorican foldings which are so well shown in the structure of the chalk downs and the Wealden rocks. It was also seen from the charts that near the French coast there was a remarkable gorge stretching away from near Cape Blanc Nez to the North Sea, which was clearly an old drainage line, and may have some connexion with the river system which existed before the Dover Strait was pierced. There is an important bank off Dungeness, called by the French "Roc d'Angleterre", and it may be that here is an uprise of the Wealden rocks which underlie the Ness. A paper by Dr. W. M. Whittard was read on "Fossil Vertebrates from the Weald."

A large party of geologists visited Mr. Lewis Abbott's collection at 8 Grand Parade, attracted thither by the discoveries made by Mr. Abbott when the ground was excavated for the building of the White Rock Pavilion. White Rock proves to be a white chalky marl comparable to the Chalky Boulder Clay of elsewhere, containing many foreign boulders, and evidencing widespread glacial action. A large 'hand-axe' was found in the marl, and the implement was striated on its worked faces. In the upper layers of the section were found the remains of kitchen-middens, these being of later date than the glacial marl. The marl had been visited by officers of the Geological Survey, and they had accepted the glacial interpretation of the marl. In the construction of the new road here the Wadhurst Clay had been laid bare, and a whorl of a giant gasteropod was shown which had been obtained thence. The mollusc must have been several feet long. Several of the best specimens obtained by Mr. Abbott have been required for the Geological Museum. The glaciation of the south of England must now be an accepted fact.

A public evening lantern lecture was given by Mr. Edward A. Martin on "Some Amenities of the South Downs" at the White Rock Pavilion, where there was a large attendance. A fascinating cinema natural history lecture was given by Dr. Clarence Tierney to a large audience of children, and Mr. E. J. Bedford addressed another juvenile audience on "Wild Flowers."

The Union was stated to comprise seventy-eight societies, almost all of whom sent delegates to the Congress, and in addition there were many individual members of these societies present, whilst the Congress was also supported by a large number of the towns-people, and the Hastings and St. Leonards Natural History Society, at whose invitation the Congress was held there. At the Representatives' Meeting (the parliament of the Union) an invitation was brought from Rochester to hold next year's Congress at that city, when the local natural history society will celebrate its jubilee. The honorary secretary announced that Sir Martin Conway had accepted the post of president for 1928.

University and Educational Intelligence.

Birmingham.—The chair of physiology, which will be vacated by the retirement of Prof. E. Wace Carlier at the end of the present session, is to be filled by the appointment of Dr. I. de Burgh Daly, lecturer in experimental physiology in the Welsh National School of Medicine, University of Wales, Cardiff.

The following are to be among the recipients of the honorary degree of LL.D. on July 2: Sir Arthur Schuster, honorary professor of physics in the University of Manchester; Dr. A. C. Seward, Downing professor of botany in the University of Cambridge; Prof. Arthur Lapworth, professor of chemistry, University of Manchester; Sir David Ferrier, emeritus professor of neuropathology, King's College, London; Sir Watson Cheyne, Bart., and Sir Walter Fletcher, Secretary of the Medical Research Council.

Cambridge.—The Rev. G. A. Weekes, Master of Sidney Sussex College, has been re-elected Vice-Chancellor for the ensuing academic year. Major P. A. MacMahon has been appointed Rouse Ball Lecturer, and will lecture on June 7 on "The Present Stage of Knowledge of the Theory of Determinants."

Mr. L. A. Pars, Jesus College, and Mr. H. A. Newman, St. John's College, have been elected university lecturers in mathematics.

Dr. Ernest Brown has been appointed to represent the University at the centenary of the University of Toronto.

Edinburgh.—The Senatus Academicus has agreed to offer the Degree of Doctor of Laws to the following, for conferment at the Special Graduation Ceremonial on July 20, on the occasion of the visit to Edinburgh of the British Medical Association: Lord Dawson of Penn, Physician in Ordinary to His Majesty the King; Dr. A. Donald (Manchester); Dr. C. E. Douglas (Cupar); Sir William Hale-White (London); Mr. R. G. Hogarth (Nottingham); Dr. W. Hunter (London); Dr. T. H. Milroy (Belfast); Sir Berkeley Moynihan, Bart. (Leeds); Sir J. H. Parsons (London); Sir Humphry Rolleston, Bart. (Cambridge); Dr. G. F. Still (London); Mr. W. Trotter (London); Sir Almroth Wright (London); Prof. Vittorio Ascoli, professor of clinical medicine, Rome; M. Jules Bordet, director of the Pasteur Institute, Brussels; Prof. Harvey Cushing, professor of surgery, Harvard University; Prof. C. L. Dana, professor of nervous diseases, Cornell University; Prof. Knud Faber, professor of medicine, University of Copenhagen; Prof. Jan van der Hoeve, professor of ophthalmology, University of Leyden; Prof. Otto Meyerhoff, professor of physiology, University of Berlin; Prof. Otto Naegeli, professor of medicine, University of Zurich; Prof. W. S. Thayer, professor emeritus of medicine, Johns Hopkins University; M. T. M. Tuffier, Academy of Medicine, Paris.

Oxford.—It is proposed to confer the honorary degree of D.Sc. upon Sir Robert Hadfield, Bart., and Dr. Richard Willstätter, professor of chemistry in the University of Munich, on Thursday, June 30; and the honorary degree of D.D. upon the Very Rev. W. R. Inge, Dean of St. Paul's, on the following day.

Sir William Dunn's Trustees have offered to provide a sum of £2000 for the endowment of a Departmental Library at their recently opened School of Pathology. A decree of acceptance and thanks will be promulgated on June 7.

The Royal College of Surgeons of England announces that the subject for the Jacksonian Prize for 1927 is "The Pathology, Diagnosis, and Treatment of Bronchiectasis and Abscess of the Lung," and that competing essays must reach the secretary not later than Dec. 31. The subject for the Jacksonian Prize of 1928 is "The Surgical Treatment of Pulmonary Tuberculosis."

The subject of the Unity History School to be held this year at Woodbrooke College on July 29–Aug. 6 is "Unity in Industry." As in previous years, the 'school' is being organised by Mr. F. S. Marvin, who will discuss the general problem of industrial unity, while other lectures will deal with the 'Industrial Revolution,' the population problem, science and industry, industrial welfare, and the industrialisation of backward races. Applications to attend must reach the honorary secretary, Miss A. R. Wells, Woodbrooke, Selly Oak, near Birmingham, by June 30.

The Empire Cotton Growing Corporation proposes to award in July next, to candidates of British nationality, a limited number of research and advanced study studentships for work in relation to cotton-growing. Each studentship will be tenable for one year, and of the value of £250 plus a further amount for necessary expenses. The research studentships are intended to enable graduates with a leaning towards research to receive training in research methods from leaders in their subject; the advanced study studentships are to enable men to receive specialised instruction in order to equip them for agricultural posts in cotton-growing countries. Further particulars of the studentships and application forms may be obtained from the Secretary of the Corporation, Millbank House, 2 Wood Street, Millbank, S.W.1. Candidates should state whether their application is for a senior or a junior studentship. Completed forms must reach the Corporation not later than June 21.

THE Principal Officer's report recently published on the work of the University of London during the year 1926–27 indicates a steady growth. Admissions (including no fewer than 382 graduates of other universities) numbered 7668, as compared with 3852 in the last year before the War and 7577 in 1925; there were 8967 candidates at degree examinations, including 1585 external students; the roll of internal students now comprises 9342 names. Among other interesting new developments the report mentions the institution of chairs of international law at the School of Economics and of bacteriology and epidemiology at the School of Hygiene and Tropical Medicine; a Ph.D. degree in the faculty of music, and diplomas in archæology, public administration, anthropology, and nursing; the extension to University, King's, and East London Colleges of the plan, recently adopted in regard to the Imperial College, whereby alternative papers are set in the Final B.Sc. (Engineering) examination for internal students at the college; and an undertaking to contribute £200 a year for five years towards the maintenance of a British Institute in Paris. In connexion with university extension work were instituted a record of distinguished service and a system of stipendiary lectureships. Many benefactions are acknowledged; among them a gift of £180,000 from the Laura Spelman Rockefeller Memorial Trustees to the School of Economics. The report concludes with a reference to what, for the moment, overshadows all other interests of the University,—the decision to purchase eleven acres of land in Bloomsbury as its permanent home.

THE Association of Teachers in Technical Institutions held its annual conference at Plymouth on June 4. During the past year there have been abundant signs of increased appreciation of the value, both cultural and economic, of technical education, and this formed the chief theme of the presidential address delivered by Mr. H. Hall. The relationships of technical education to other forms of education and to industry and commerce, which have lately undergone investigation by a committee under the chairmanship of the late Lord Emmott, have in the past been associated with a good deal of scepticism as to the validity of the claims of technical teachers that their craft can provide the means of life as well as the means of livelihood; that they have on one hand opportunities not inferior to those of teachers in more academic fields, of developing character and endowing with the capacity for successful civic and social life, and, on the other hand, the power of increasing the capacity of their pupils for efficient service to industry and commerce. That this scepticism has, during the past year, been giving place to a more appreciative attitude is shown by quotations from speeches by the president of the Board of Education and the president of the National Union of Teachers, and from the reports of the Balfour Committee on factors in industrial and commercial efficiency and the Hadow Committee on the education of the adolescent. Mr. Hall ends this part of his address with a plea for definite action, and especially for an increase in day courses as recommended by the president of the Board on Mar. 31, when he said: "So long as employers are content with technical education of this type [evening classes], valuable as it is, they are missing the opportunity of conferring upon the work of their industry the dignity of a craft or profession for which a definite standard of education is required."

Calendar of Discovery and Invention.

June 12, 1712.—In Devereux Court, Strand, are the Grecian Chambers. Until 1843, on this site stood the Grecian Coffee House, which two hundred years ago was a resort for the fellows of the Royal Society. Thoresby the antiquarian, in his diary for June 12, 1712, wrote: "Attended Royal Society, where were present the President, Sir Isaac Newton, both the secretaries, the two professors from Oxford, Dr. Halley and Keill, with others, whose company we afterwards enjoyed at the Grecian Coffee House."

June 13, 1901.—Dewar's work on the liquefaction of gases was referred to under May 28, 1898, when he first liquefied hydrogen. Three years later, on June 13, 1901, he successfully transported through the streets from the laboratory of the Royal Institution to the rooms of the Royal Society no less than a gallon of the liquid gas.

June 14, 1699.—In the *Philosophical Transactions*, vol. 21, p. 228, is the entry: "Mr. Savery, June 14, 1699. Entertained the Royal Society with showing a small model of his engine for raising water by the help of fire, which he set to work before them; the experiment succeeded according to expectation, and to their satisfaction."

June 15, 1919.—Alcock and Whitten Brown, on June 14-15, 1919, made the first direct flight across the North Atlantic from Newfoundland to Ireland. Their machine, now in the Science Museum, South Kensington, was a Vickers-Vimy biplane fitted with two 360-h.p. Rolls-Royce engines. Assisted by a following wind, they flew a distance of 1890 miles in 15 hours 57 minutes at an average speed of 118·5 miles per hour.

June 16, 1657.—The application of the pendulum to clocks was due to Huygens, who on June 16, 1657, presented his first pendulum clock to the States General of Holland. The following year he described his clock in detail in a brochure entitled "Horologium," and fifteen years later gave the theory in his fine work, "Horologium Oscillatorium," published in Paris.

June 16, 1864.—Stokes announced to the Royal Society his discovery that when diluted blood is treated with certain reducing agents, its colour and spectrum undergo a reversible change. "The colouring matter of the blood, like indigo, is capable of existing in two states of oxidation, distinguishable by a difference of colour and a fundamental difference in the action on the spectrum. It may be made to pass from the more to the less oxidised state by the action of suitable reducing agents, and recovers its oxygen by absorption from the air." Of additional interest is that this discovery, fundamentally important for physiology and biochemistry, regarding this animal respiratory pigment, should have been contributed by a mathematical physicist.

June 16, 1874.—The Cavendish Laboratory at Cambridge owes its existence to the Duke of Devonshire, who had been impressed with the need of institutions for experimental research. The Laboratory was formally opened on June 16, 1874, though the inaugural lecture had been given by Clerk Maxwell three years previously.

June 17, 1885.—Among the most famous balloonists of last century was Henry Coxwell, whose last ascent as made on June 17, 1885, when he was sixty-six years of age. Many of his ascents were made for scientific purposes, and it was with him that Glaisher, on Sept. 5, 1862, rose to a height of seven miles. Glaisher became insensible, Coxwell's hands became frozen, and he opened the valve of the balloon by tugging at the cord with his teeth. E. C. S.

Societies and Academies.

LONDON.

Royal Society, June 2.—**S. Chapman** and **A. E. Ludlam**: A theoretical discussion of certain elastic constants of calcite and crystalline sodium nitrate. Upper limits are found theoretically for two of the elastic constants of calcite and crystalline sodium nitrate; the calculations are based on the theoretical determinations of the potential energy of these crystals in various configurations. The theoretical upper limits found are larger than Voigt's measured values for calcite, but of the same order of magnitude.

R. W. Fenning and **H. T. Tizard**: The dissociation of carbon dioxide at high temperatures. If mixtures of carbon monoxide, oxygen, and nitrogen are exploded, the explosion pressure is greatest when there is an excess of carbon monoxide in the mixture. If no nitrogen is present the explosion pressure is greatest when the ratio $CO/O_2 = 2$, and varies very little with the composition of the mixture near the maximum point. When nitrogen is present, a determination of the composition of the mixture which gives the greatest rise of pressure on explosion, leads to a simple method for determining the dissociation of carbon dioxide at high temperatures. Accepted values for the dissociation of carbon dioxide at high temperatures are much too high.

L. H. Callendar: The influence of boundary films on corrosive action. The surface of metals liable to local corrosion is normally more or less covered with an oxide film; where this film is of higher potential than the metal itself, its distribution determines the location of the primary cathode and anode areas before the metal is in contact with the electrolyte. The distribution of this oxide film is determined by the presence of foreign substances on the metal surface and by irregularities in the surface itself. When metal and electrolyte come into contact, the oxide film is the primary cathode, metal passes into solution at unoxidised parts of the surface, and continuance of this current between cathode film and metal is dependent on the prevention of diffusion of oxygen to the anodes; the original location of cathode and anode areas is likely to be altered by the distribution of oxygen within the solution. Boundary resistance between electrodes and electrolyte is an indicator of rate of corrosion. The normal cathodic oxide film formed in air has little effect, but thicker oxide films formed by heating give high boundary resistance and must tend to retard corrosive action: oxidising electrolytes also retard by increasing boundary resistance. With aluminium, boundary resistance increases with increasing dilution of electrolyte and increasing thickness of any oxide film present on the metal surface.

F. H. Constable: The cause of the colours shown during the oxidation of metallic copper. Evidence has been collected showing that interference is the cause of the colours shown during initial stages of oxidation. The order of production of the colours corresponds with that for interference colours of air films of increasing thickness seen by transmitted light. Fall in electrical conductivity and mass of oxygen taken up per unit area of surface are proportional to the equivalent air thickness of the copper oxide film. The wave-lengths of the maxima in absorption or reflection bands, in the spectrum of light reflected from the film, move towards the red as the thickness of the film increases. Finally, general absorption causes blackness of film.

C. F. Elam: Tensile tests on alloy crystals (Parts i., ii., and iii.). Crystals of alloys of aluminium and zinc, containing up to 18 per cent. zinc, have been prepared by the method of straining followed by heat-treatment. The direction and plane of slip under distortion is in a direction parallel to the diagonal of the cube (*i.e.* in a {110} direction) and on an octahedral {111} plane, as in aluminium. The alloys showed increased resistance to shear with increased zinc content, and the amount of elongation before fracture was reduced. Crystals were made by melting brass rods, containing 70 per cent. copper and 30 per cent. zinc, in graphite tubes and slowly cooling from one end. In every case these showed that slip under distortion occurred on an octahedral {111} plane in a {110} direction, as in copper. The elongation before fracture amounted in one case to 168 per cent. Resistance to shear in early stages of extension was slightly less than that of pure copper; final shear-stress was greater.

A. J. Bradley and **J. Thewlis**: The crystal structure of α-manganese. Westgren and Phragmen have shown that the structure is cubic, the lattice dimensions being 8·894 Å.U. It contains 58 atoms per unit cell. The exact position of the atoms is defined by five parameters. The structure is based on a single body-centred cubic lattice, but each lattice point is replaced by a cluster of atoms, with tetrahedral symmetry. The interatomic distances range from 2·25 Å.U. to 2·95 Å.U., indicating an unequal distribution of electrons between the various atoms.

N. R. Sen: On Fresnel's convection coefficient in general relativity. A simple explanation of Fresnel's convection coefficient is furnished by Einstein's addition law of two velocities. But one would expect to obtain this law in the case of the addition of a small velocity to the velocity of light directly from Maxwell's electromagnetic equations in a moving material medium. We can take a gravitational field and try to obtain solutions of the form $f(x_1 - vt)$ of the modified Maxwell equations, in which there are two electromagnetic tensors F and H, which must also be connected by two more simple relations in a transparent medium. The conditions for the existence of the above plane waves lead to an algebraic quadratic equation for v, whose solution really gives Einstein's addition theorem for the electromagnetic wave velocity and the velocity of the medium.

Helga Pearson: On the skulls of early tertiary Suidæ, together with an account of the otic region in some other primitive Artiodactyla. Starting with the problem of the inter-relationships of the early tertiary Suidæ, it became necessary to reject from this family certain genera usually associated with it. This led to an examination of the otic region in those families, such as the Anthracotheriidæ and Hippopotamidæ, that are generally regarded as most nearly allied to the Suidæ. Finally, all available early Artiodactyl skulls were examined and an attempt was made to trace the probable course of evolution in this order of the otic region of the skull.

A. W. Greenwood and **F. A. E. Crew**: Studies on the relation of gonadic structure to plumage characterisation in the domestic fowl. (ii.) The developmental capon and poularde. It is not uncommon for a fowl as it attains maturity to assume the characters of the agonadic bird instead of developing male, or female, plumage and head furnishings. Such a bird is termed the developmental capon or poularde, and is in its characterisation entirely similar to the surgically caponised or ovariotomised individual. Examination of these birds, however, reveals that testicular or ovarian tissue is present though greatly reduced. This may be due to inherent imperfection in the gonadic tissue itself, or to imperfection in the environment (the body) in which it develops.

F. A. E. Crew: The laying hen with cock's plumage. (Part iii.) The cock-feathered laying hen is a female, normal in every respect save that her plumage becomes as that of the agonadic bird following the moult, as the result of a transient disfunctioning of the ovary (and/or of the thyroid) at this time.

J. W. Trevan: The error of determination of toxicity. Curves expressing the relationship between mortality and dose for various drugs are discussed. It is suggested that, as a definition of toxicity, the average lethal dose for the animal and drug in question should be used. The expression 'minimal lethal dose' should be dropped, because of the various meanings that have been attached to it. The average lethal dose is represented, with sufficient accuracy, by the dose which kills 50 per cent. of a random sample of animals; the statistical error is at a minimum for doses in the neighbourhood of the average lethal dose.

C. K. Drinker and **E. D. Churchill**: A graphite suspension for intravital injection of capillaries. This fluid possesses qualities essential for physiological injections if employed in perfusion experiments in that the graphite particles are able to mix with blood without agglutinating and to pass through the capillaries without sticking to the walls. When injections of the fluid are made in intact animals, intravascular agglutination of the particles begins in about ten minutes and embolism takes place.

Geological Society, May 11.—**P. G. H. Boswell**: The Salopian rocks and tectonics of the district south-west of Ruthin (Denbighshire). The district extends southwards and south-westwards from Ruthin, and is bounded on the south by the northernmost fault (or Braich Fault) of the Llanelidan system of east-and-west fractures. It is composed of Salopian beds folded gently on axes running east-north-east and west-south-west. The western half of the area may be regarded as anticlinal; the eastern half shows a synclinal tendency. The dominant faulting is north-eastward in trend. Like the folding and cleavage (which is generally parallel to the fold-axes, with a steep northward dip), it is regarded as Caledonian. North-and-south faulting, which borders the Vale of Clwyd in the north-eastern part of the area, is of post-Carboniferous age. Similarly, the east-and-west Braich Fault limits the fault-system of north-eastern trend to the south, and is also post-Carboniferous. Where the north-east and south-west fault-system meets the north-and-south fractures and the Braich Fault, the beds are much shattered. The Braich Fault is an old fracture, throwing to the north in post-Silurian times, along which tearing movement took place at a post-Carboniferous date.—**R. O. Blackie**: The geology of the country between Llanelidan and Bryneglwys (Denbighshire). The Llanelidan district consists largely of Lower Ludlow deposits. Wenlock beds are restricted to the area west and north-west of Gwyddelwern, but there is also a small inlier in the centre of the Llanelidan anticlinorium. The Wenlock Series comprises the Denbighshire Grit, the upper limit of which is approximately the summit of the zone of *Cyrtograptus rigidus*; also a series of slab-like beds, representing the zone of *C. lundgreni*. The region came under the influence of the Caledonian movements, which resulted in folding, cleavage, and dominant south-west and north-east faulting. The Llanelidan and Bryneglwys Faults date also from this time. In post-Carboniferous times further movements of a torsional character affected the region, and movement was renewed along the master-faults, together with the initiation of smaller adjustment-dislocations between the Llanelidan and Bryneglwys Faults.

Physical Society, May 13.—**J. W. T. Walsh**: The theory of luminescence in radioactive luminous compound. From the brightness curves of compounds made with the same luminescent material but with different radium concentrations, the brightness-time relationship is found to be of the form $B=rf(rt)$, where r is the radium content. The brightness curves are in excellent agreement with Rutherford's original theory of the destruction of active centres, provided this be combined with a simple hypothesis as to the cause of the progressive increase in the light absorption of the material which has been found experimentally. This leads to the following brightness-time relationship: $\log\{B/(b+B)\}+kt+a=0$, where a, b, and k are constants, of which the last two are proportional to the radioactive concentration for any given grade of luminescent material.—**E. Mallett**: Distortion of resonance curves of electrically driven tuning-forks. Resonance curves with increasing exciting currents show increasing distortion until an unstable state is reached in which the amplitude for a given current over a certain frequency range can have two different values, depending upon whether the frequency has been approached from above or below. The indication here is that a decrease of resonant frequency takes place with increase of amplitude, and also an increase of damping. Static experiments show a departure from the straight line law both in the case of the deflexion of the fork prongs for given loads, and the flux change through the core for a given deflexion of the prongs. The effect of such departures on the equation of motion is considered mathematically, and it is shown that the term depending on the cube of the amplitude is the most important. Another effect of the non-linearity is the possibility of producing fundamental frequency vibrations in the fork by exciting currents of double frequency; distortions of a second type consist of 'coupled circuit' effects: these, at large amplitudes, are modified by distortions of the first type.

Dublin.

Royal Irish Academy, May 9.—**A. W. Conway**: Undulatory theory of two electron orbits. In a previous paper (with G. Keating) the question of the quantisation of certain symmetrical orbits (with certain assumptions as regards the force between the electrons) was dealt with. The resulting negative energy terms were of the enhanced Rydberg form $4R/(n+\mu)^2$ for two different types of orbits. The principles of the wave mechanics of Schrödinger are now applied, and for one type of orbit the terms are of the correct Rydberg form $R/(n+\mu)^2$.

Paris.

Academy of Sciences, May 2.—**Paul Appell**: The creation of an institute of physico-chemical biology by M. Edmond de Rothschild.—**Mesnager** and **Veyrier**: The determination of the resistance of a structure on a reduced model. In the case of a dam, the effect of the water pressure can be studied experimentally on a small scale model by using a liquid of higher density than water (mercury) and material of smaller resistance than the material actually used on the dam.—**G. Friedel**: The existence of a salt dome in the Oligocene potash basin of the Haut-Rhin.—**Charles Nicolle** and **V. Lumbroso**: A new contribution to the knowledge of natural granular conjunctivitis of the rabbit. In man, and in the Barbary ape, the virus of the rabbit determines a granular conjunctivitis which differs from trachoma by its long incubation and its primitive and principal localisation on the lower eyelid.—**Jules Amar**: The origin and evolution of cancer. Reasons are given for the view that cancer is a parasitic disease.—E. Cartan: The topology of simple real continued groups.—D. V. Widder: A theorem on the series of Dirichlet.—J. J. Gergen: Some theorems in Taylor's series having generalised gaps.—André Charrueau: The surfaces of equilibrium relating to a liquid mass of revolution possessing surface tension, in uniform rotation.—Giacobini: The Paris-Winnecke comet. On April 27, at the Paris Observatory, this comet showed as an elliptical nebulosity, major axis 10″ to 12″, with a marked condensation at one of the foci; magnitude between 12·5 and 13.—Henri George: Two qualities of silica glass. Discussion of the effect of the presence of moisture in the powdered silica before fusion on the properties of the glass.—R. Mesny: The energy radiated by electro-magnetic networks.—Armand de Gramont: A gyroscope kept in motion by an alternating current supplied through its axes of suspension.—Josef Mikuláš Mohr: The relation between the classes of lines (of the spectrum) determined by temperature and the groups of lines determined by pressure.—F. Croze and J. Gilles: The structure of the second order spectrum of nitrogen.—C. Mihul: The electronic configurations corresponding to the emission of the third order spectrum of oxygen.—M. Lambrey and D. Chalonge: The use of the discharge in hydrogen as a source of a continuous spectrum in the ultra-violet. The discharge in hydrogen has already been used as a source of a continuous spectrum in the extreme ultra-violet, but its use has been difficult and the intensity feeble. Details are given for setting up a hydrogen tube working with perfect regularity for long periods and giving an intense continuous spectrum.—P. Gabiano: The alkaline cuprotartrates.—P. Lecomte du Noüy: An anomaly in the evaporation of solutions of sodium oleate and of digitonin at high dilutions.—F. Bourion and E. Rouyer: The boiling-point constant of aqueous solutions of potassium chloride and molecular equilibria of resorcinol in this medium.—P. Job: The substitution of ethylenediamine for ammonia in complexes in solution. In most of the complex ammonia salts one molecule of ethylenediamine can replace two molecules of ammonia. With thallium salts ammonia forms the complex ion $Tl(NH_3)$. Ethylenediamine gives the ion (Tl en) in which the ethylenediamine replaces the ammonia molecule for molecule.—A. Andant: The application of the spectrography of fluorescence to the examination of organic compounds. Results are given for olive oil, vaseline oil, and castor oil. The method is of analytical value.—Jean Bouldoires: The transformations undergone by aluminium bronzes.—G. Gilta: The isomerism of *p*-hydroxyphenylarsenic acid.—A. Demay: Hercynian strata and folds of the Massif of Maures.—R. Bureau: Anomalies of long duration in the propagation of short [Hertzian] waves.—Jacques Maheu and J. Chartier: The botanical origin of the lesser striated Ipecacuanha. This has been identified with *Manettia ignita* of the family of the Rubiaceæ.—L. Maume and J. Dulac: The minimum of toxicity of a mixture of two salts with regard to plants.—Lucien Daniel: Two new grafts.—L. Carpentier and G. Thieulin: The direct measurement of the magnitude of the retinal images in the dog and cat.—Ph. Joyet-Lavergne: The proportion of glutathione reduced is a character of the sexualisation of the cytoplasm.—Th. Moreux: Solar activity and certain phenomena of vegetation.—A. Goris and L. Lachaise: The phylactic action of brucine towards strychnine. If 8 mgm. or 10 mgm. of brucine is injected into dogs and one hour later a mortal dose of strychnine, all the dogs survive.—Etienne Wolff: The adaptation of amœba to saline solutions. Cysts without a membrane.

Official Publications Received.

BRITISH.

List of Members of the British Astronomical Association, September 1926. Pp. 37. (London.)

The Lister Institute of Preventive Medicine. Report of the Governing Body, 1927. Pp. 28. (London.)

Institute of Marine Engineers, Incorporated. Session 1926. Vol. 38. Thirty-eighth Annual Report and Financial Statement and Minutes of Annual Meeting held on Friday, March 11th, 1927, at 6.30 p.m. in the Institute Premises, the Minories, Tower Hill, London, E.1. Pp. ccvii. (London.)

Proceedings of the London Mathematical Society. Second Series. Vol. 25. Pp. ii+546. (London: Francis Hodgson.)

Irrigation in the Empire. Memorandum and Questionnaire by Dr. B. A. Keen. Pp. 8. (London: Empire Marketing Board.)

Ceylon Journal of Science. Section B: Zoology and Geology. Spolia Zeylanica. Vol. 14, Part 1, April 30th. Edited by Dr. Joseph Pearson. Pp. 138+12 plates. (Colombo: Colombo Museum; London: Dulau and Co., Ltd.) 3 rupees.

The Scientific Proceedings of the Royal Dublin Society. Vol. 18 (N.S.), No. 34: The Production of the Resting-Spores of *Phytophthora infestans* on Potato Tubers. By Dr. Paul A. Murphy. Pp. 407-412+1 plate. 1s. Vol. 18 (N.S.), No. 35: Some Further Cases of the Production of Diseased Shoots by Potato Tubers attacked by *Phytophthora infestans*, and a Demonstration of Alternative Sources of Foliage and Tuber Infection. By Dr. Paul A. Murphy and Robert M'Kay. Pp. 413-422+1 plate. 1s. 6d. Vol. 18 (N.S.), No. 36: Methylene-Blue (Reductase Test) in Milk Grading. By Dr. M. Grimes, H. S. Boyd Barrett and Dr. J. Reilly. Pp. 437-441. 6d. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.)

Western Australia: Geological Survey. Bulletin No. 87. A Geological Reconnaissance in the Central and Eastern Divisions between 122° 30′ and 123° 30′ E. Longitude and 25° 30′ and 28° 15′ S. Latitude. By H. W. B. Talbot. Pp. 30+5 plates. Bulletin No. 93: The Geology of portions of the Kimberley Division, with special reference to the Fitzroy Basin and the Possibilities of the Occurrence of Mineral Oil. By T. Blatchford. Pp. 56+8 maps. (Perth: Fred. Wm. Simpson.)

Abstracts of Dissertations approved for the Ph.D., M.Sc. and M.Litt. Degrees in the University of Cambridge for the Academical Year 1925–1926. Published by Authority. Pp. 74. (Cambridge: Printed at the University Press.)

Aeronautical Research Committee: Reports and Memoranda. No. 1044 (Ae. 231): Full Scale Pressure Plotting Experiments on Hull and Fins of H.M.A. R. 33. By Lieut.-Col. V. C. Richmond. Pp. 26+30 plates. 1s. 9d. net. No. 1073 (Ae. 255): Full Scale Measurement of Lift and Drag of a Bristol Fighter with Slotted Upper Wings and Standard Lower Wings. By J. K. Hardy. (A.2.b. Stability-Full Scale Experiments, 44.—T. 2350.) Pp. 3+3 plates. 4d. net. No. 1060: Reports and Memoranda of the Aeronautical Research Committee published between the 1st January 1925 and the 28th February 1927. Pp. 8. 4d. net. No. 1071: Wind Tunnel Tests of Aerofoil R.A.F. 34. By H. Davies. (A.3.a. Aerofoils-General, 171.—T. 2364.) Pp. 5. 4d. net. (London: H.M. Stationery Office.)

University of Reading: The National Institute for Research in Dairying. Annual Report for the Year ending 31st July 1926. Pp. 62. (Reading.)

FOREIGN.

Havsforskningsinstitutets Skrift. No. 36: Översikt av isarna vintern 1919–20. Av Risto Jurwa. Referat: Übersicht der Eisverhältnisse im Winter 1919–20 an den Küsten Finnlands. Pp. 30+15 plates. 20 Fmk. No. 37: Översikt av isarna vintern 1914–15. Av Gunnar Granquist. Referat: Übersicht der Eisverhältnisse im Winter 1914–15 an den Küsten Finnlands. Pp. 45. 20 Fmk. No. 38: Regelmässige Beobachtungen von Temperatur und Salzgehalt des Meeres im Jahre 1924. Von Gunnar Granquist. Pp. 46. 20 Fmk. No. 39: Die thalassologische Terminfahrt im Jahre 1925. Von Erik Palmén. Pp. 22+1 plate. 10 Fmk. No. 40: Översikt av isarna vintern 1915–16. Av Gunnar Granquist. Referat: Übersicht der Eisverhältnisse im Winter 1915–16 an den Küsten Finnlands. Pp. 56. 22 Fmk. No. 41: Havsforskningsinstitutets verksamhet under år 1925. Redogörelse avgiven av Rolf Witting. Pp. 21. 5 Fmk. No. 42: Översikt av isarna vintern 1917–18. Av Gunnar Granquist. Referat: Übersicht der Eisverhältnisse im Winter 1917–18 an den Küsten Finnlands. Pp. 40. 18 Fmk. No. 43: Dagliga vattenståndsuppgifter 1924. Av Henrik Renquist. Referat: Tägliche Wasserstandsangaben 1924. Pp. 48. 9 Fmk. No. 44: Översikt av isarna vintern 1924–25. Av Gunnar Granquist. Referat: Übersicht der Eisverhältnisse im Winter 1924–25 an den Küsten Finnlands. Pp. 48. (Helsingfors.)

Akademie der Wissenschaften in Wien: Mathematisch-naturwissenschaftliche Klasse. Anzeiger. Jahrgang 63, 1926. Pp. viii+206. (Wien.)

Journal of the College of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol. 17, Part 3: Studies on the Correlations between Morphological Characters, Chromosome-number and Resistance to *Puccinia triticina* in Pentaploid-Bastards of Wheat. By Yoshihiko Tochinai and Hitoshi Kihara. Pp. 133-161. (Sapporo.)

Svenska Linné-Sällskapets Årsskrift. Årgång 10, 1927. Pp. v+178. (Uppsala: Almquist and Wiksells Boktryckeri-A.-B.)

Proceedings of the United States National Museum. Vol. 70, Art. 9: A Review of the South American Two-winged Flies of the Family Syrphidae. By Raymond C. Shannon. (No. 2658.) Pp. 34+1 plate. Vol. 70, Art. 22: Richmond Faunal Zones in Warren and Clinton Counties, Ohio. By George M. Austin. (No. 2671.) Pp. 18. Vol. 71, Art. 3: On a Collection of Orthopteroid Insects from Java made by Owen Bryant and William Palmer in 1909. By A. N. Caudell. (No. 2675.) Pp. 42. Vol. 71, Art. 9: The Digger Wasps of North America of the Genus Podalonia (Psammophila). By H. T. Fernald. (No. 2681.) Pp. 42+2 plates. (Washington, D.C.: Government Printing Office.)

Bergens Museums Aarbok, 1926. Hefte 1. Naturvidenskabelig Rekke. Pp. 21+17+19+10+28+56. (Bergen: A.-S. John Griegs Boktrykkeri.)

Bergens Museum. Aarsberetning 1925–1926. Pp. 90. (Bergen: A.-S. John Griegs Boktrykkeri.)

Conseil Permanent International pour l'Exploration de la Mer. Rapports et procès-verbaux des réunions. Vol. 43, Rapports (Mai 1927). Pp. 50. Bulletin hydrographique pour l'année 1926. Pp. 58. Bulletin hydrographique. Appendice d'observations de l'Allemagne pour 1919–1925 et de la Lettonie pour 1925 et 1926. Pp. 20. (Copenhague: Andr. Fred. Høst et fils.)

Annuaire de l'Observatoire Royal de Belgique. 95me année, 1928. Par P. Stroobant. Pp. iii+291. (Bruxelles.)

Pubblicazioni della R. Università degli Studi di Firenze. Fascicolo N. 43: Osservazioni e memorie del R. Osservatorio Astrofisico di Arcetri. Pp. 51. Immagini spettroscopiche del bordo solare osservate a Catania e Zurigo nel 1922–23. (Appendice al Fascicolo N. 40 delle Osservazioni e memorie del R. Osservatorio Astrofisico di Arcetri.) Pp. 8+6 tavole. (Firenze.)

Catalogue.

The Indian Empire: being a Catalogue of Books, Paintings and Engravings relating to India, Ceylon, Tibet, Burma, Persia and Afghanistan. (No. 497.) Pp. 78. (London: Francis Edwards.)

Diary of Societies.

SATURDAY, June 11.

Royal Society of Medicine (Laryngology and Otology Sections) (Summer Meeting).—Otological Session (Clinical Meeting), at 10.—Dr. G. Portmann: The Saccus Endolymphaticus and an Operation for Draining the same for the Relief of Vertigo.—Cases and Specimens by Dr. A. R. Friel, A. R. Tweedie, Dr. T. B. Jobson, N. Barnett, E. H. Barnes, and others.—Demonstration of Stereoscopic Transparencies of Specimens of the Temporal Bone, by Dr. A. Gray.

Biochemical Society (in Biochemical Department, The Museum, Oxford), at 2.—V. B. Wigglesworth: The Digestion of Carbohydrates in the Cockroach.—P. C. Raiment: (a) The Oxidation of Uric Acid by Hydrogen Peroxide; (b) The Estimation of Oxalic Acid in Urine; (c) The Estimation of Oxaluric Acid in Urine.—P. Eggleton and M. G. Eggleton: The Chemistry of Phosphagen.—C. R. Harington and W. McCartney: The Erlenmeyer Amino-acid Synthesis.—F. Hawking: Synthesis of Vitamin B (Torulin) by Yeast.—H. W. Kinnersley and R. A. Peters: Use of Norite in the Concentration of Torulin.—P. G. Marshall and H. D. Kay: The Presence of a Nucleotide in Milk.—R. M. Beck and R. K. Cannan: The Peptic Digestion of Gelatin.—J. T. Irving: Metabolism of Glucose by Kidney Tissue in Vitro.—Demonstrations:—A Colorimetric Method for the Determination of the pH of Minute Amounts of Fluid, by V. B. Wigglesworth.—Synthesis of a Bacterial Growth Factor by Meningococcus, by J. Orr Ewing and V. B. Reader.—A Simple Fluorophotometer, by J. H. Jeffree and B. T. Squires.

MONDAY, June 13.

Royal Irish Academy, at 4.15.

Victoria Institute (at Central Buildings, Westminster), at 4.30.—Dr. A. T. Schofield: Time and Eternity (Annual Address).

Institute of Actuaries (Annual General Meeting), at 5.

Royal Geographical Society (at Æolian Hall), at 8.30.—H. E. Hurst: The Hydrology of the Nile.

British Psychological Society (Medical Section) (jointly with the Education Section) (at Royal Society of Medicine), at 8.30.—Dr. S. Ferenczi: The Psychology of the Pre-School Child.

Medical Society of London.—Prof. H. Cushing: Annual Oration.

TUESDAY, June 14.

Institution of Gas Engineers (Annual General Meeting) (at Institution of Electrical Engineers), at 10 a.m.—J. Wilkinson: Presidential Address.—Seventeenth Report of the Gas Investigation Committee.—Examination of Products of Combustion from Typical Gas Appliances—Part II. Gas Fires.—At 3.15.—T. Carmichael: Modern Carbonising Economics as exemplified by Results and Working Costs at the Works of the Portsmouth Gas Company.—Eighteenth Report of the Gas Investigation Committee—Studies in Carbonisation.—Part II. Size of Coal, Admixture, Inorganic Compounds.

Royal College of Physicians of London, at 5.—Sir Frederick Gowland Hopkins: The Task of Biochemistry (Croonian Lectures).

Mineralogical Society, at 5.30.—A. F. Hallimond: On the Atomic Volume Relations in Certain Isomorphous Series.—Dr. P. K. Ghosh: Petrology of the Bodmin Moor Granite (Eastern Part).—Prof. P. G. H. Boswell: On the Distribution of Purple Zircon in British Sedimentary Rocks.—Dr. J. Drugman: On β-quartz Twins from Cornwall.—E. V. Holt and Dr. H. F. Harwood: The Separation of Manganese in Rock Analysis.—Dr. L. J. Spencer: Corundum Twins from Transvaal.

London Natural History Society (at 40 Winchester House, E.C.), at 6.30.—Sir Frank Baines: Westminster Hall: its History, Architectural Design and Preservation.

Quekett Microscopical Club, at 7.30.—Prof. H. Graham Cannon: The Feeding Mechanisms of Crustacea.

Röntgen Society (Royal Society of Medicine), at 8.30.—Sir J. J. Thomson: The Structure of the Atom and Radiation (Silvanus Thompson Memorial Lecture).

Institution of Electrical Engineers (Summer Meeting) (at North-Eastern Centre).

WEDNESDAY, June 15.

Institution of Gas Engineers (Annual General Meeting) (at Institution of Electrical Engineers), at 10 a.m.—G. M. Gill: Ovens as a Gas-Works Carbonising Plant.—Report of the Institution Gas Fellowship on Influence of the Ash Constituents in the Carbonisation and Gasification of Coal.—Part III. Gasification of Special Cokes: (a) In Steam, J. A. Sutcliffe and Prof. J. W. Cobb; (b) In Carbon Dioxide, W. R. Branson and Prof. J. W. Cobb; (c) In Oxygen, F. J. Dent and Prof. J. W. Cobb.—At 2.15.—J. P. Leather: The Dry Cooling of Coke.—Report of the Refractory Materials Joint Committee.

Society of Glass Technology (in University, Sheffield), at 2.30.—R. Wigginton: Gaseous Fuels for Furnace Heating.—Prof. W. E. S. Turner and F. Winks: The Thermal Expansion of Some Boric Oxide Glasses and some Remarks on the Influence of the Inhomogeneity of the Glass.

Royal Meteorological Society, at 5.—J. Edmund Clark, I. D. Margary, and R. Marshall: Report on the Phenological Observations in the British Isles, December 1925 to November 1926.—Dr. G. C. Simpson: Past Climates.—H. M. Treloar: The Variation of Eddy Viscosity with Wind Velocity and Season. A Study based on Pilot Balloon Observations at Melbourne.

Geological Society of London, at 5.30.—J. E. Richey: The Structural Relations of the Mourne Granites (Ireland).—Dr. W. F. Whittard: The Stratigraphy of the Valentian Rocks of Shropshire: The Main Outcrop.

Folk-Lore Society (at University College), at 8.—Miss Eleanor Hull: Female Deities in the British Isles.

Electroplaters' and Depositors' Technical Society (at Northampton Polytechnic Institute), at 8.15.—E. Downs: Electro-refining of Silver.

Eugenics Society (at Royal Society), at 8.30.—Miss Evelyn Lawrence: Intelligence of Institution Children.

Institution of Electrical Engineers (Summer Meeting) (at North-Eastern Centre).

THURSDAY, June 16.

Institution of Gas Engineers (Annual General Meeting) (at Institution of Electrical Engineers), at 10 a.m.—J. H. Canning: Some Experiences of Gas Service.

Royal Society, at 4.30.

Royal Society of Medicine (Dermatology Section), at 5.—Dr. Parkes Weber: Early Angioma Serpiginosum, with Another Early Case (previously shown) for Comparison.—Dr. G. B. Dowling: Rare Seborrhoide of the Face (Pringle): Acne Agminata.

Royal College of Physicians of London, at 5.—Sir Frederick Gowland Hopkins: The Task of Biochemistry (Croonian Lectures).

Chemical Society, at 8.—I. Vogel: Syntheses of Cyclic Compounds. Part I. Ethyl βγ-dimethyl Butane ααδδ-tetracarboxylate and Some Cyclobutane Compounds Derived Therefrom.—B. Cavanagh: A New Method of (Absolute) Potentiometric Titration.

Royal Society of Tropical Medicine and Hygiene (at 11 Chandos Street, W.) (Annual General Meeting), at 8.15.—Induction of New President, Prof. J. W. W. Stephens. Presentation of Chalmers Medal to H. L. Duke.—D. L. Fabian Hirst: Rat Flea Surveys and their Use as Plague Preventive Measures.

Newcomen Society for the Study of the History of Engineering and Technology (Summer Meeting).

Institution of Electrical Engineers (Summer Meeting) (at North-Eastern Centre).

FRIDAY, June 17.

Royal Society of Medicine (Obstetrics and Gynæcology Section), at 8.—Dr. R. A. Gibbons: The Cause of the Onset of Labour.

Oxford University Junior Scientific Club (in Department of Zoology and Comparative Anatomy, Oxford), at 8.15.—W. T. Griffiths: Nickel and its Alloys.

Association of Economic Biologists (at South-Eastern Agricultural College, Wye).

Newcomen Society for the Study of the History of Engineering and Technology (Summer Meeting).

Institution of Electrical Engineers (Summer Meeting) (at North-Eastern Centre).

SATURDAY, June 18.

North of England Institute of Mining and Mechanical Engineers, at 2.30.

Physiological Society (at Middlesex Hospital).

Association of Economic Biologists (at South-Eastern Agricultural College, Wye).

Newcomen Society for the Study of the History of Engineering and Technology (Summer Meeting).

PUBLIC LECTURES.

SUNDAY, June 12.

Guildhouse (Eccleston Square, S.W.), at 3.30.—Dr. R. E. M. Wheeler: Some of the Ancient Civilisations of Britain.

TUESDAY, June 14.

East London College, at 5.—Sir Frank Dyson: The Eclipse of the Sun.

University College, at 8.30.—Prof. J. A. Fleming: A Hundred Years of Electrical Engineering.

SUNDAY, June 19.

Guildhouse (Eccleston Square, S.W.), at 3.30.—C. L. Woolley: Recent Discoveries at Ur.

CONGRESS.

June 16 and 17.

Congress of the Internal Combustion Engine (at Padua).

SATURDAY, JUNE 18, 1927.

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Co-operation in Forestry and Forest Products Research.

CONSIDERING the importance of wood and its by-products in the necessities of life, it is strange how comparatively little systematic action has been taken in England to study the constitution of wood-substance and the structure and properties of the different timbers in relation to their uses. Much of our knowledge, whether it be of the chemistry of wood or its mechanical and physical behaviour, is empirical.

Most of the difficulties encountered in connexion with timber are due to its extraordinary lack of uniformity. When anything goes wrong, as, for example, when an aeroplane strut breaks without warning, the first question always asked is: 'Is this a normal piece of wood?' A piece of wood may be regarded as normal or abnormal from several different points of view; for example, in its behaviour under mechanical stress, in either its minute or gross structure, with respect to its treatment during seasoning, or as representing normal growing conditions. The interrelation of these aspects is of very great importance. A timber is usually judged in practice by its mechanical properties, but until our knowledge of the connexion between structure, growth, seasoning, and strength is increased, it will remain impossible to assess the mechanical properties of a piece of timber with any degree of certainty otherwise than by actually breaking a test stick. Further, will the growing conditions which the forester aims at as ideal, produce timber which gives the best results under mechanical tests?

One can only hope to solve such problems by the close collaboration of a number of specialists in different branches of research. The establishment, under the Department of Scientific and Industrial Research, of the Forest Products Research Laboratory at Princes Risborough, within sixteen miles of the Imperial Forestry Institute at Oxford, has opened up a prospect of such collaboration which both institutions have been quick to grasp. These two institutions together provide the much-needed link between the sylviculturist on one hand and the wood-user on the other, harnessing science to the task of informing the sylviculturist of the species to plant, the quality of timber desired, and the means of obtaining it, and the wood-user of the right timber for the several uses, based on mechanical and physical properties, with the best method of preparing it for use.

In this work the Imperial Forestry Institute is primarily concerned with the living tree, from the germination of the seed to the felling of the tree for timber: from this point the problems are proper to the Forest Products Research Laboratory, which is concerned with mechanical strength, seasoning, preservation, and manufacture of the timber, and with the investigation of by-products. There exists, however, a common ground, more especially in wood technology, mycology, and entomology. In these three subjects, in order to secure the closest co-operation, the staffs of the two institutions have been practically combined to form a joint section, working on a joint programme, the Forest Products staff being housed at the Imperial Forestry Institute at Oxford.

In dealing with complex problems, it has thus been possible to co-ordinate very different aspects, and the personal contact between the two staffs greatly facilitates the dissemination of information and ideas. For example, a number of independent lines of research, which are being undertaken, have been so arranged that their results may form the basis of an investigation into the problem of 'brashness,' which means an unexpected brittleness in a wood which is not normally brittle; this is a problem of particular importance in aeroplane construction. Other problems coming within this system of co-operative research are the relation between anatomical variation, mechanical strength, and growing conditions; the range of variation consistent with normal mechanical strength; the physical and chemical factors involved in the process of seasoning; the effect of different degrees of fungal attack and the possible relation between insect and fungal attack. In the chemistry of wood-substance, a beginning has been made by arranging for work to be carried out under Sir James Irvine at the University of St. Andrews. This will be closely co-ordinated with the physico-chemical research included in the joint programme of the Laboratory and the Imperial Forestry Institute, especially in its relation to shrinking and swelling.

The problems connected with colonial timbers also can only be effectively solved by a combined investigation in which both the growing of the timber and its utilisation are fully considered. Here the co-operation of the systematist and the wood technologist forms an indispensable link, and is very strong under the existing arrangements. Such a combined scheme has already been put forward, in a joint pamphlet which has been circulated to the Forest Services of those parts of the British Empire which do not yet possess facilities to undertake the work themselves.

An Orthodox View of Witchcraft.

The History of Witchcraft and Demonology. B Montague Summers. (The History of Civilis tion Series.) Pp. xv + 353 + 8 plates. (London Kegan Paul and Co., Ltd.; New York: Alfre A. Knopf, 1926.) 12*s.* 6*d.* net.

ANY anthropologist into whose hands this boo may come will rub his eyes to find himse translated to an atmosphere of theological controversy which might well be that of the seventeent century. Indeed, he may even go further and as why a series entitled "L'Évolution de l'Humanité," or, in translation, "A History of Civilisation," i which an impersonally objective treatment of it subject matter might reasonably be expecte should include a book so subjective in outlook a Dr. Summers' "History of Witchcraft and Demonology." It is surely not the function of the studen of the development of thought and belief to inquir into the truth or validity of the tenets he examine or to obtrude his own beliefs; his interest lies i the process of development and its product; h may legitimately be expected to regard them a objective matters of fact, the truth or falsity o their content being irrelevant to his purpose.

Dr. Summers, however, believes in witches, an accepts the witchcraft belief as set forth in contemporary or nearly contemporary accounts an in the reports of witch trials as in the main a tru record of a real cult and an actual manifestation o the principle of evil. He believes in the possibl efficacy of a malediction. It is true that he acknowledges that the leader of the witches' coven wa often proved to be a man—Francis Bothwell, fo example, for political and other reasons was suspected of inspiring the Berwick witches who wer accused of plotting against James I., and the suspicion is made almost a certainty by his notoriou reputation as a 'witch master' when afterward living at Naples—but he says:

> "When God's Ape the Demon can work s successfully and obtain not merely devoted adherents but fervent worshippers by human agency there is plainly no need for him to manifest himsel in person either to particular individuals or at th Sabbats, but none the less that he can do so, an has done so, is certain, since such is the sense o the Church, and there are many striking cases i the records and trials which are to be explaine in no other way."

It is therefore with scarcely a feeling of surpris that we read: "anthropology alone offers no explanation of witchcraft. Only the trained theologian can adequately treat the subject." In th true spirit of the orthodox when a belief in witchcraft was a test of orthodoxy, Dr. Summers gives a long list of fathers of the early Church, theologians, lawyers, and writers on witchcraft who held firmly to the belief in the reality of the existence and powers of the witch ; but he might just as well have cited an almost equally long list of those who denied it. It is significant that while references to Sprenger and the "Malleus Maleficarum"—the bible of the witchfinder—Boguet, Bodin, and de Spina are frequent, such writers as Scott, Cotta, Bernard, Wierus, Webster, Becker, and Hutchinson, critics of the belief, are barely mentioned, if at all. As most of these writers are English, it may be that Dr. Summers will deal faithfully with them in the later volume in which he promises to discuss the witchcraft belief in its local manifestation in England, France, Germany, and elsewhere.

Bodin, the famous French lawyer and writer of the sixteenth century, defined a witch as "Sorcier est celuy qui par moyens diaboliques sciemment s'efforce de parvenir à quelque chose" (a sorcerer is one who by commerce with the devil has a full intention of attaining some end). British jurists laid rather more stress on the existence of a pact with the devil. Virtually there was a general agreement in the witchcraft prosecutions in the fifteenth, sixteenth, and seventeenth centuries throughout Europe and in the American colonies, that whatever may have been the specific act upon which the accusation was brought, witchcraft involved a league with the devil and a renunciation of Christianity. The frenzied fear of the populace was responsible for the cruelty of the duckings and other forms of outrage and the witch-findings of Hopkins and his peers in the small towns and villages of Puritan England and Presbyterian Scotland of the seventeenth century, but it was the animus of the Church against the heretic which brought literally thousands to their death after the issue of the Bull of Innocent VIII. in 1484. It is quite correct, as Dr. Summers points out, that the witchcraft prosecutions did not begin with this Bull ; but they increased enormously in number after its promulgation, and it was responsible for the activities of Sprenger and his colleagues in Germany, inspiring them to the authorship of the "Malleus Maleficarum," which became the textbook and code of those who emulated their achievements in prosecution elsewhere.

The charges of heresy and witchcraft, it is true, were almost interchangeable, and accusations of witchcraft were brought freely against heretical sects ; but it is difficult to accept Dr. Summers' view that the Bull of 1484 was directed against heresy alone. The various activities of witches are specifically enumerated ; the renunciation of the faith is mentioned as an added crime, not as the head and front of the offending, however much importance may attach to it. In order to support his view that the witch as heretic was the object of the Church's attack and that the outburst of witch prosecutions of the fifteenth century was no new thing, Dr. Summers cites earlier Bulls of the popes and refers to earlier heresy trials. Among these he quotes an account of an assembly of Manichees at which the devil appeared. These Manichees were condemned by a synod at Orleans in 1022. But a similar account, almost identical in wording, appears in Walter Mapes about the Paturini, and much the same sort of accusation was brought against the assemblies of most of the many schismatic sects which sprang up about this time. It has all the flavour of a commonplace of ecclesiastical scandal and gossip which was fastened on to any sect that was forced by circumstances to meet in secret. Dr. Summers, however, is convinced of the connexion of heresy and witchcraft. He says :

> "The full fury of the prosecution burst over England . . . shortly after the era of a great religious upheaval, when the work of rehabilitation and recovery so nobly initiated by Queen Mary I. had been wrecked owing to the pride, lust, and baseness of her sister. In Scotland, envenomed to the core with the poison of Calvin and Knox, fire and cord were seldom at rest. It is clear that heresy had brought witchcraft swiftly in its train."

In Ireland, on the other hand, for obvious reasons, "the devil's claws were finely clipped."

It is not possible here to follow Dr. Summers in all the consequences which are entailed by this acceptance of the purely heretical character of witchcraft and the orthodox attitude of the Roman Church towards such matters, which almost necessarily involves the view that at the present day witchcraft persists in the celebration of the black mass, satanism, and spiritualism—a conclusion which an anthropologist at least would find it difficult to accept, for psychologically and culturally they are poles apart. It explains why he traces witchcraft back to the Gnostics and the Manichæans, and also why he rejects the anthropological view. His rejection of the contribution of anthropology to the study of witchcraft might carry more weight had it been clear that he is fully aware of what that contribution is. The anthropologist no longer accepts, if he ever did, "devil-worship," the term used by Dr. Summers, as an adequate description of a primitive cult, secret or other; nor incidentally is 'Bantu' a territorial term. The belief in the witch is widespread in time and space. Possibly its origin may go back to palæolithic times. The animal-headed human figure depicted in the cavern at Les Eyziès, or the leader of the dance in the paintings of Cogul, may be the ancestors of the leader of the coven. Witchcraft exists to-day among both primitive peoples and the peasant populations of Europe. At a time of universal credulity it was elevated by the Church, as a self-protective measure, into a heresy; but that does not place it outside the scope of the science which studies the beliefs of man as objective facts of experience, or remove it from the category of primitive religions, even if it survived only in a mutilated or attenuated form.

In conclusion, although there are still many controversial points upon which it has not been possible to touch, it must be said in fairness to Dr. Summers, and to those who are interested in one of the most extraordinary chapters in history, that notwithstanding the point of view from which the book is written, and the bias which has determined the line of discussion of the origin of the belief, this is the best and most complete account of the witch cult in mediæval and early modern Europe which has been written in recent years.

Tungsten.

Tungsten: a Treatise on its Metallurgy, Properties, and Applications. By Dr. Colin J. Smithells. Pp. viii + 167 + 33 plates. (London: Chapman and Hall, Ltd., 1926.) 21*s.* net.

TUNGSTEN is a metal which presents so many points of special interest both from the practical and the scientific aspect, that a treatise dealing with it in detail is welcome. From the time when tungstic acid was first prepared by Scheele in 1781 and Bergman soon afterwards isolated the metal, tungsten remained a rare metal, and it only began to assume industrial importance as the result of the work of Oxland in 1847–57. The important position which the metal now occupies, both in connexion with the electric lamp industry and for the production of high-speed tool steel, is an often-quoted but none the less instructive example of the way in which a curiosity of the laboratory may become a valuable product of industry. Apart from this historical interest, however, the properties of tungsten itself are remarkable. The metal, at room temperatures and slightly above these, is chemically inert, and uses based on its resistance to oxidation and to chemical attack are numerous and important. Its application to electric contacts may be recalled. On the other hand, at higher temperatures, tungsten becomes chemically much more active, combining readily with oxygen and even exerting a strong reducing action on the oxides of other elements. For this reason, both in the manufacturing processes applied to it and in its practical applications at elevated temperatures, it must be kept out of contact with oxygen or other oxidising agencies. As a result we find that it is hot-worked usually in an atmosphere of hydrogen, or maintained in a vacuum or in an inert atmosphere such as nitrogen or argon.

Tungsten is remarkable from yet another point of view. If we take account of what may be termed the 'relative temperatures' of metals, tungsten at room temperature must be regarded as one of the 'coldest' substances which it is possible to obtain; *i.e.* it is further removed from its melting point than any other metal. Since the properties of metals are closely associated with their 'distance' from their melting points, it is not surprising to find that the mechanical properties of tungsten are correspondingly extreme. At room temperature it is probably the strongest known material, and it can be produced in a ductile condition only in special circumstances. When thus produced, however, it can be cold-worked and work-hardened like other metals, but with this difference, that plastic deformation applied to it at any temperature much below 1500° C. still produces work-hardness. The re-crystallisation normally associated with annealing only occurs above that temperature, which thus corresponds roughly with, say, 550° C. for iron. Finally, tungsten cannot, like other metals, be melted and cast, since its melting temperature is so high that it is not yet possible to obtain a refractory capable of holding molten tungsten. It remains to be seen whether this will yet be accomplished, or whether it will be worth while. Dr. Smithells states that tungsten which has been fused is rendered permanently brittle, but recent work on other metals at least suggests that such brittleness may be due to the presence of traces of inter-crystalline impurities which readily escape detection.

Meanwhile, the process of manufacture of ductile tungsten is again of special interest. Like wrought iron, the metal is brought into a coherent solid form by the high-temperature welding of small particles without previous fusion. The metal is obtained in the form of powder, of the desired degree of purity, and this is welded into the form of rods by heating the compressed material in an atmosphere of hydrogen and then 'swaging' it while hot. The rods thus produced are 'sintered' by heating them electrically by the direct passage of a heavy electric current, and the material thus consolidated can then be worked down, while hot, by further hammering. Ultimately it can be drawn down to exceedingly fine wire in the cold. Perhaps the most curious fact of all is that such wire shows a considerable degree of ductility, but is rendered completely brittle by heating it up to or beyond 1500° C. The proximate explanation is that in the cold-drawn wire the crystals are elongated into long fibre-like bodies, so that bending or twisting of the wire implies deformation of the crystals themselves, but little or no relative motion between adjacent crystals. After annealing, the crystals resume an equi-axed arrangement, and any plastic deformation implies considerable relative movement of the crystals with the result that, at room temperature, rupture immediately occurs. This phenomenon has been interpreted, both by Z. Jeffries and the present writer, in terms of the 'amorphous cement' theory, according to which there is a thin layer of non-crystalline metal between adjacent crystals. At temperatures very far below the normal melting point of the metal, this amorphous layer is brittle and incapable of even a minute amount of flow. A similar phenomenon occurs in iron at very low temperatures.

The question just briefly discussed is an example of the way in which the behaviour of tungsten is apt to become the testing-ground of theories of the structure and behaviour of metals in general. In fact, a considerable portion of Dr. Smithells' book, and perhaps the most interesting portion of it, is devoted to an account of a series of researches of a general fundamental nature in which tungsten has served as the material for experiment. In view of the difficult technique, often involving the use of very fine wires and of exceedingly high temperatures in high vacua or in carefully controlled atmospheres, it is surprising to find the degree of success which these investigations have attained. The researches of Goucher and of Smithells himself are excellent examples. The only misgiving is whether tungsten, which differs in so many remarkable ways from other metals, is the best choice for work of this kind. No doubt the most fundamental phenomena are common to all metals, but each of them has its own peculiarities, and tungsten perhaps more so than the majority.

Dr. Smithells' book deals with the various matters already mentioned, and many others bearing on the manufacture, properties, and applications of tungsten in a lucid and interesting manner. The matter of the book is selected in a way which speaks at once of the fact that it is the work of a man writing on his own subject, largely on the basis of direct personal knowledge, and the book is to be valued accordingly. The only section to which this does not apply so fully is that relating to the use of tungsten in alloy steels. No doubt this section has been included for the sake of completeness, but it is not on the same level as the rest of the book. One can scarcely blame Dr. Smithells because he is not also an alloy-steel metallurgist, but it might have been wiser to omit this section.

Finally, the photo-micrographs of tungsten which are given in the book deserve a word of praise. They frequently represent sections of very thin wire wound in spirals and have been obtained by an ingenious technique used with great skill. Fortunately, the structures encountered in a pure or nearly pure metal like tungsten are sufficiently simple to be readily understood by the technical reader even if he is not a trained metallographer. On the whole, Dr. Smithells' book is to be commended as a clear and well-written monograph on a subject of great interest. W. Rosenhain.

Parasites and Man.

(1) *Contributions from the Harvard Institute for Tropical Biology and Medicine, No. 4. Medical Report of the Hamilton Rice Seventh Expedition to the Amazon, in conjunction with the Department of Tropical Medicine of Harvard University, 1924–1925.* Members of the Medical Expedition: Prof. Richard P. Strong, Prof. Joseph C. Bequaert, Prof. George C. Shattuck, Ralph E. Wheeler. Pp. xvi + 313 + 70 plates. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1926.) 20*s*. net.

(2) *Animal Parasites and Human Disease.* By Dr. Asa C. Chandler. Third edition, revised. Pp. xiii + 573. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1926.) 22*s*. 6*d*. net.

(1) THIS attractive volume, printed and illustrated with the expensive excellence that is found so frequently in American publications, is a prelude to adventure in a scientific sense rather than a record of completed researches. While this is true up to a point of the actual work

accomplished, the summing up of the knowledge concerning all the matters touched upon is vividly and skilfully done, so that the reader is presented with the state of knowledge in connexion with the matter in hand in relation to the particular experience and contribution made by the members of the expedition. This is well shown by the very interesting account of yellow fever. Scarcely any cases occurred during the period spent by the expedition in Brazil; the preventive measures, and probably also a spontaneous remission, have resulted in the almost total disappearance of the disease. The writer, however, summarises the studies carried out on the last epidemic at Bahia in 1923, and concludes that the evidence incriminating *Leptospira icteroides* was strengthened and the identity of the yellow fever occurring in Palmeira and Bahia with that which is found in Mexico, Peru, and Colombia was established.

Among the medical matters investigated, the chapter on malaria and splenomegaly is of particular interest. Malaria, in spite of quinine and of all the knowledge that has been accumulated in the last thirty years, remains the most prevalent and serious disease of Amazonia, as indeed of practically all tropical and many subtropical countries. It is true even now that the disease is accepted fatalistically in countries much more civilised and better administered than that traversed by the expedition. The workers show the wide experience that they bring to the problem, which is well handled, and the ravages of the disease as an agent of human degradation and of actual depopulation of considerable areas are forcibly and eloquently described.

The chapters dealing with insect life are, as might be expected, of great interest, tropical South America being a naturalists' paradise in this respect. Simulium and Tabanus were found in large numbers, and are reported upon in some detail. The summing up of the rôle of Tabanus species in the transmission of disease, especially protozoan diseases such as trypanosomiasis, is judicial and well informed. The problem of the transmission of the trypanosome of Mal de Caderas remains, however, unsolved.

The expedition, as has already been shown, had a happy and catholic taste in knowledge, and there is an excellent account of a new dipterous fly *Malacophagula neotropica* (Bequaert), parasitic in a snail. This chapter also gives an account of the arthropod enemies of snails.

(2) If the report of the Hamilton Rice expedition cast its net in a wide and leisurely way into a sea of tropical life, and brought back a mixed catch which is set out with a truly scientific interest in knowledge for itself, the second book to be considered deals with the wide range of its subject in a totally different spirit.

In "Animal Parasites and Human Disease," Dr. Chandler takes his title to heart from the first page, and we are considering animal parasites and animal life strictly from the view-point of the doctor and the sanitarian. The author knows what he is about, and the preface states the position with admirable clarity. It purports to give the results of scientific research in this particular field in such a way that it shall be useful to those who seek to apply them to practical problems. Dr. Chandler is inclined to reprove the scientific worker for his failure in propaganda, but this vivid, condensed, and readable treatment of the subject is itself a proof that the task of exposition is probably better executed by those who are applying the fruits of inquiry rather than by those whose energies are absorbed in the pursuit of new knowledge.

There is here quite frankly a different attitude towards knowledge, and the energetic insistence of this type of statement requires gifts which differ from those usually possessed by the research worker.

The book succeeds in its aim. It contains an enormous amount of information; it deals with all the protozoan parasites of man, their life-histories, means of transmission, and with the history of the insect vectors—this last section is particularly well done considering the scope of the book. All the spirochætes of man are described; all the 'worms' parasitic in man, with a brief chapter on leeches, and all the arthropods which are either parasites of man or suck his blood, are included; and all this is achieved within the compass of 528 pages. It is in the main a very accurate and fair presentation of the case, and if there are some rather sweeping generalisations and a slightly optimistic sense of progress and achievement, as, for example, in the account of malaria, it is nevertheless a sound and valuable book and excellently suited to the reader for whom it is designed.

One wonders if such doubtful forms as the Chlamydozoa and *Cyclasterion scarlatinæ* are worth including in this book, but the fact that they are mentioned gives a measure of the completeness with which the author has dealt with the subject.

These two books are an interesting comment upon each other, for the Hamilton Rice report reveals how lamentably the use of knowledge lags behind its possession.

Cainozoic Plants.

British Museum (Natural History): Catalogue of Cainozoic Plants in the Department of Geology. Vol. 1: *The Bembridge Flora.* By Eleanor Mary Reid and Marjorie Elizabeth Jane Chandler. With a section on the Charophyta, by James Groves. Pp. viii + 206 + 12 plates. (London: British Museum (Natural History), 1926.) 15*s.*

THE appearance of the first volume of the catalogue of Cainozoic plants in the British Museum is a noteworthy event. Catalogues of the older plant remains have already appeared, but the great and valuable stores of Tertiary plants in the national collections have received scant attention.

The plant remains of this period are of great interest but present exceptional difficulties; they are derived chiefly from Angiosperms, often closely resembling modern genera or even species, but usually are represented by leaf impressions only. These are so difficult to identify that many eminent botanists have regarded the task as practically impossible, and have thrown doubt upon the validity of much of the work already done. If, however, we could be sure of the identity of the remains which have come down to us, we should have material of great value for the solution of some of the difficult problems of plant evolution and distribution.

In the present catalogue a number of species are described, identified, and established on grounds which are far more secure than those which Hooker and others have criticised. In the Bembridge beds there are not merely leaf impressions but also the remains, often very well preserved, of seeds and fruits; many of these can be compared so closely with the seeds and fruits of living plants that it is impossible to doubt the correctness of their determination. The cuticle-structure of some of the leaves is preserved also, and in several cases their identification may be taken as firmly established.

Among the more interesting forms described may be mentioned a new species of Azolla, founded on astonishingly well-preserved material, and most interesting in view of the re-establishment of this genus in England in recent years. Dr. Florin has aided the authors in establishing the presence of a new species of Araucarites, while Sequoia, Cupressus, and Pinus were also present. The majority of the Angiosperms have been compared with plants now existing and have been given suitable generic and specific names, but others which could not be matched with any known living forms are described and placed in the non-committal genera Carpolithus and Dicotylophyllum. The remains of Charophyta are abundant in the flora and have been treated in a separate section by Mr. James Groves, the well-known authority on this group.

One of the most interesting parts of the volume is the introduction, in which, among other matters, the authors give an analysis of the flora and compare it with other fossil and modern floras. It is shown that the Bembridge flora has a greater affinity with the plants living to-day in eastern Asia and North America than with the present European flora, and the authors point out how greatly the recent work on the floras of China and the neighbouring lands affects the determinations and conclusions of the earlier writers on Cainozoic plants.

H. H. T.

Our Bookshelf.

(1) *Wireless Pictures and Television: a Practical Description of the Telegraphy of Pictures, Photographs, and Visual Images.* By T. Thorne Baker. Pp. x + 188. (London: Constable and Co., Ltd., 1926.) 6*s.* 6*d.* net.

(2) *Television (Seeing by Wire or Wireless).* By Alfred Dinsdale. Pp. 62. (London: Sir Isaac Pitman and Sons, Ltd., 1926.) 2*s.* net.

(1) Applied photo-electricity has perhaps developed more rapidly than any other branch of applied physics. The discoveries of outstanding importance which have resulted from photo-electric observations have stimulated the production of improved apparatus, and this has had a healthy reaction upon practical applications. Of these, telephotography and television are among the most interesting. Of the former, Mr. Thorne Baker was one of the most distinguished pioneers, and it is well to have a book on the subject from his pen. The various methods of picture transmission, such as those of Bakewell, Caselli, Charbonelle, Korn, Belin, and others, are described, but considerably more might well have been said about the code method by which Sanger Shepherd transmitted the race for the America Cup. A great deal is naturally said about selenium, and most of it correctly, though the date of discovery of its light-sensitiveness is given as 1861 instead of 1872, and the very prevalent mistake is made of describing it as particularly sensitive to red light, the great response to which is solely due to the abundance of energy in the red end of the spectra of most terrestrial sources.

The successes achieved by Korn with his selenium transmitter in 1907 have almost been forgotten; the speed was five seconds per line, in spite of the 'lag' of selenium. Portraits were transmitted between Paris, London, and Berlin, of a quality suitable for newspaper reproduction. More recent methods, employing photo-electric cells with a million-fold amplification, may be somewhat speedier but scarcely give a better quality, though giving more detail. The method worked out by Mr.

Herbert Ives, of the American Telegraph and Telephone Co., is particularly interesting in view of the fact that it has recently been successfully applied to television. The difficulty of synchronisation is in this case got over by phonic wheels at the sending and receiving stations, both controlled by the same tuning fork.

(2) Mr. Dinsdale's booklet purports to give a general statement of the problem of television and the various attempts to solve it. Much is said about the results achieved by Mr. J. L. Baird, and said in a rather rhetorical manner, without, however, giving sufficient data to judge of the originality of the method adopted. But at a time when the solution of the problem is being achieved simultaneously along different lines, it is useful even to have a partial description of one of the successful systems. E. E. F. D'A.

The Yearbook of the Universities of the Empire, 1927. Edited by Walter H. Dawson. Published for the Universities Bureau of the British Empire. Pp. xii + 858. (London: G. Bell and Sons, Ltd., 1927.) 7*s.* 6*d.* net.

A BOOK such as this falls, usually, into one of two classes. It can be an indispensable (if tiresome) list of names to which are attached groups of more or less intelligible statistics, a somewhat dull reiteration of policy, an urbane or challenging record of things accomplished, some indigestible lumps of 'useful information,' and a dissertation which veils but thinly the propagandist hand. In this case it goes so swiftly to the reference shelf that, almost in the same breath, we bid it welcome and farewell. Alternatively, it may present all the names, statistics, records, and useful information, and still retain the subtle quality of the dictionary. We take it up to seek some special point of interest and find ourselves absorbed delightfully by old things which appear in new light, and by new things which stimulate and surprise.

It is in the second class we would place the present volume. It is an admirable condensation of authentic information which could otherwise be obtained only by research in individual university calendars—volumes comprising in their total some 50,000 pages. From each of these, extracts concerning personnel, organisation, regulations, and recent activities have been taken and arranged in an interesting and easily accessible form.

With regard to the details of the libraries, laboratories, degrees, scholarships, publications, etc., of each university, we need say no more than that no essential point appears to have been neglected. We must not fail to note, however, that, especially in the appendices, information appears which helps vastly to see how the conception of university work is growing and to note the widening of its function in modern life. One appendix gives lists of the titles of theses accepted for research degrees. Another sets out a remarkably full list of centres of research outside the universities. Details of professional schools show how the advanced work in technical and other colleges is becoming identified with the university. Descriptions of varied careers give some indication of the delimitation of university aims. Finally, an account of federations and foreign universities cannot fail to leave some impression of the vast possibilities of international understanding yet to be explored.

Beyond the Milky Way. By George Ellery Hale. Pp. xv + 105. (New York and London: Charles Scribner's Sons, 1926.) 7*s.* 6*d.* net.

THIS little book is a continuation of the series of books by Dr. Hale, of which "The New Heavens" and "The Depths of the Universe" were the first representatives. Like those volumes, it forms an *édition de luxe* of three articles which originally appeared in *Scribner's Magazine*: their titles are—"The Oriental Ancestry of the Telescope"; "Heat from the Stars"; "Beyond the Milky Way." They are plentifully illustrated by excellent photographs and diagrams, and the volume in every respect reaches the high standard set by its predecessors.

The contents of the chapters have already been separately noticed in NATURE on their first appearances, so that little of a descriptive character need be said. It is unnecessary also to comment on the accuracy and lucidity of style of a book by Dr. Hale. His main purpose in this excellent little series is "to tell of some of the principal advances of my associates, with such historical background as to render their significance clear," but that he is not rigidly restricted by the terms of this statement is shown by the fact that the first chapter of the present volume has been constructed, as he says, from material gathered chiefly in Egypt and England. The book will be found useful, not only by the general reader, for whom it is evident that it has chiefly been prepared, but also by workers in astronomy who often feel the need of authoritative statements on matters of current research, disentangled from the mass of detail in which they are necessarily involved in the original publications. A new attitude to the problem of variable stars is inevitably induced in the reader by the direct statement that "while to the eye X-Cygni is 10,000 times as bright at maximum as at minimum, the total radiation as measured with a thermocouple undergoes a variation of only 1·7 times." We hope that Dr. Hale will continue to enrich the literature of astronomy by further additions to this admirable series.

An Introduction to the Study of Map Projections. By J. A. Steers. With a Foreword by F. Debenham. Pp. xxiii + 189. (London: University of London Press, Ltd., 1927.) 7*s.* 6*d.* net.

THE author of this book, realising that geographers are not necessarily mathematicians, has attempted to explain the subject of map projections. The construction of the map has frequently been beyond the geographical student. The mathematician could arrive at an understanding of this section, but to others it was a morass where few found the path, and the majority had to be content with an imperfect notion. This book, without any pretence to finality, provides a guide for such geographers. It is introductory in the true sense.

It may be urged that the book would be improved by dealing with difficulties as they arise, instead of deferring them—for example, in the zenithal equidistant, the equatorial and oblique cases are postponed to p. 154, whilst the simple polar case is treated on p. 54. The answer to this is that the difficulty is left until the reader is able to deal with such problems. The lucidity of the constructions, geographical and trigonometrical, and the liberal use of figures (even simple cases are illustrated) will be appreciated.

The author might realise that having used a light inside the sphere to project, it is a difficult task to "bring back the shadows." Again, the definition of latitude (p. 19) lacks precision. It is unfortunate that the determination of latitude and longitude was not incorporated into chap. iii., and some of the figures would be improved by the use of perspective. Figs. 12 and 13 illustrate this; the latter gives a much better impression of the sphere. Visualisation is a great help to any reader. The book will be welcomed as a sound basis for the study of map productions.

J. Eling Colclough.

The Statesman's Year Book: Statistical and Historical Annual of the States of the World for 1927. Edited by Dr. M. Epstein. Sixty-fourth Annual Publication. Revised after Official Returns. Pp. xxxviii + 1519. (London: Macmillan and Co., Ltd., 1927.) 20*s*. net.

For the first time for forty-three years this volume makes its appearance without the name of Sir J. Scott Keltie on the title-page. The joint editor for the last seventeen years now has sole control. The volume is arranged on the plan of past years, which it would be difficult to improve, and, as usual, has been revised in every detail according to the latest returns available. With its fifteen hundred pages it is a marvel of condensation and convenient size. The recent census figures of the Irish Free State, Northern Ireland, South Africa, New Zealand, France, and Egypt are included. Improvements have been made in the section on Morocco in order to bring out the distinction between the French, Spanish, and Tangier zones. Additions are also made to the Russian section, particularly in the portion relating to central Asia and the Caucasus. The introductory tables include various statistics of world production, and there is also a section on the League of Nations. The three coloured maps illustrate African railways and political jurisdiction, the Egypt-Cyrenaica boundary, and the boundaries between Nejd, Trans-Jordan, and Iraq. The valuable bibliographies contain the most authoritative works of reference on every State.

Our Early Ancestors: an Introductory Study of Mesolithic, Neolithic, and Copper Age Cultures in Europe and Adjacent Regions. By M. C. Burkitt. Pp. xii + 243. (Cambridge: At the University Press, 1926.) 7*s*. 6*d*. net.

In attempting to give an account of the development of civilisation from the end of the palæolithic age to the bronze age in Europe and adjacent regions, within the compass of this small volume, Mr. Burkitt has essayed a very difficult task—difficult in more ways than one, for the material does not lend itself easily to systematic treatment. It has not been worked over and classified to the same extent as the material of the old stone age, and in the later stages the problem of dealing with a multiplicity of detail of which the bearing is often still obscure is complicated by ethnological questions to which the answers are still very much at the hypothetical stage. All credit is therefore due to Mr. Burkitt for the success with which he has carried out his task, even though in its later pages his book suffers from over-condensation and lack of space for adequate discussion of many doubtful points. Probably to most of his readers much of the material relating to the copper and bronze age will be seen in a new perspective, while the chapter on art brings together material which is usually scattered. It gains greatly in significance by the author's method of treatment.

Delphos: the Future of International Language. (To-day and To-morrow Series.) By E. Sylvia Pankhurst. Pp. 95. (London: Kegan Paul and Co., Ltd.; New York: E. P. Dutton and Co., n.d.) 2*s*. 6*d*. net.

The student of this recurrent and ever-present problem will welcome this extremely handy analysis of all hitherto attempted universal languages, contributed by Miss Pankhurst to the "To-day and To-morrow" series of opuscula. Both the purely 'invented' languages and those based upon existing languages are dispassionately discussed and explained, and the natural conclusion arrived at is a return to that form of the original universal language—Latin—which has been standardised by Sig. G. Peano under the name 'Interlingua' and already possesses a well-established academy. The examples given speak eloquently for themselves, for 'Interlingua' does not require to be 'learnt' by any ordinarily educated person. Any one with a superficial knowledge of elementary Latin can produce his own 'Interlingua,' and use it in case of need.

E. H.-A.

The Annual Register: a Review of Public Events at Home and Abroad for the Year 1926. Edited by Dr. M. Epstein. Pp. xiv + 341 + 192. (London: Longmans, Green and Co., Ltd., 1927.) 30*s*. net.

This admirable volume is arranged on the usual lines. Part I. contains summaries of British foreign and imperial history, the arrangement under States greatly facilitating reference. Part II. includes a chronicle of events, an obituary of the year with short biographies, and a retrospect of literature, science, art, finance, and law. [illegible] aspect of the year's history is omitted, and [illegible] balance between different interests is well k The twelve pages in which the science of [illegible] year is recorded mention the most import researches and publications. Among the publi documents printed in full is the text of the Report of the Inter-Imperial Relation Committee that was adopted by the Imperial Conference in Novembe 1926.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Diffraction of Cathode Rays by a Thin Film.

IF a fine beam of homogeneous cathode rays is sent nearly normally through a thin celluloid film (of the order 3×10^{-6} cm. thick) and then received on a photographic plate 10 cm. away and parallel to the film, we find that the central spot formed by the undeflected rays is surrounded by rings, recalling in appearance the haloes formed by mist round the sun. A photograph so obtained is reproduced (Fig. 1). If the density of the plate is measured by a photometer at a number of points along a radius, and the intensity of the rays at these points found by using the characteristic blackening curve of the plate (see *Phil. Mag.*, vol. 1, p. 963, 1926), the rings appear as humps on the intensity-distance curves. In this way rings can be detected which may not be obvious to direct inspection. With rays of about 13,000 volts two rings have been found inside the obvious one. Traces have been found of a fourth ring in other photographs, but not more than three have been found on any one exposure. This is probably due to the limited range of intensity within which photometric measurements are feasible.

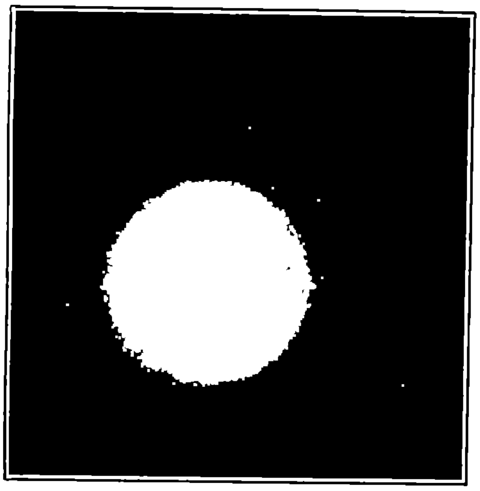

FIG. 1.

The size of the rings decreases with increasing energy of the rays, the radius of any given ring being roughly inversely proportional to the velocity, but as the rings are rather wide the measurements so far made are not very accurate. The energy of the rays, as measured by their electrostatic deflexion, varied [illegible]om 3900 volts to 16,500 volts. The rings are [illegible]pest at the higher energies and were indistinguish[illegible] at about 2500 volts. In one photograph the [illegible] of the rings were approximately 3, 5, and 6·7 [illegible]. for an energy of 13,800 volts.

[illegible] is natural to regard this phenomenon as allied [illegible] the effect found by Dymond (NATURE, Sept. 4, 1926, p. 336) for the scattering of electrons in helium, though the angles are of course much smaller than he found. This would be due partly to the greater speed [illegible] the rays giving them a smaller wave-length. Using the formula $\lambda = h/mv$ the wave-length in th above-quoted case would be $\lambda = 1{\cdot}0 \times 10^{-9}$ cm. It i quite possible that there are other rings inside o outside those observed at present, and no opinion i advanced as to whether the diffracting systems ar atoms or molecules. The disappearance of the ray at low speeds is probably due to the increased tota amount of scattering which occurs. In all, abou fifteen plates have been taken showing the effect, in- cluding some using a slit, instead of a pin hole, t limit the beam of rays. It is hoped to make furthe experiments with rays of greater energy and t obtain more accurate measurements of the size o the rings.

G. P. THOMSON.
A. REID.

University of Aberdeen,
May 24.

British Settlement in the Dominions Overseas.

HAVING read the interesting criticism in NATURE of May 14 of the annual report of the Oversea Settlement Committee, may I, as a member of that Committee, be permitted to make certain comments?

It is claimed that the report fails adequately to cover the field of activity of the Oversea Settlement Department, and that no mention is made of many of the various factors that bear more or less directly on the question of the settlement of our people in the Dominions.

The answer to this stricture is twofold. In the first place some of our earlier reports cover a wide range; but in a time of transition like the present there would be great difficulty—in fact danger—in attempting to forecast, for example, the economic results from different types of farming. Secondly, our reports are intended primarily for Parliamentary use, and are not intended for purposes of propaganda or to furnish information to would-be settlers. The latter functions properly belong to the handbooks on the various Dominions and Colonies which are prepared and issued free to inquirers by the Department. These handbooks which, it may be said, are compiled with the utmost care and are revised twice yearly, contain much of that information we are charged with omitting from our report, where its inclusion would be quite impracticable, if only on the grounds of bulk and expense.

The O.S.C. has no widespread policy of propaganda, for the simple reason that, without it, there are more migrants willing to leave our shores than the Dominions can at present absorb.

This point should be clearly understood—the volume of migration from Great Britain is governed by the absorbing power of the Dominions.

In regard to this power of absorption, I would point out that the article in NATURE overlooks the fact that New Zealand, per head of her population and *pro rata* for her area, places far more settlers than any other Dominion.

One reason for the small numbers who migrate to South Africa is that more capital is required there than is the case in the other Dominions. There are other reasons as well that it is inexpedient to discuss.

One very important point raised in the criticism is that of the suitability of previously inexperienced men for settlement upon the land. We can say quite definitely that, given the right conditions of settlement, inexperienced men can and do succeed well. The Group Settlements of Rochester and Shepperton in Victoria, Australia, are convincing proof. Started in 1910, with the settlers drawn almost entirely from our great cities, these are to-day well-developed and flourishing communities. But this form of settlement, though in the long run economic, entails heavy initial expenditure. On the other hand, to place townsmen on the land as isolated units and without adequate training and supervision is to court failure.

The comments upon the part education should play go to the very root of the matter. There is nothing to be gained by shutting our eyes to the fact that since the foreign migrant has a far more highly developed 'land sense' than the British migrant, less has to be spent upon looking after him during his early years. So far as I am aware, foreign Governments do not, and have no need to, give grants in aid of migration. But we have to deal with the fact that the drift to the town is more accentuated in the case of the Anglo-Saxon than with other nationals. Considerations of national safety demand that that tendency should be combated.

If we are to develop the empty spaces of the Empire by men of our own race, we must take the necessary steps to guide cultivators of the soil to those areas. A high degree of organisation and the full co-operation of all the Governments of the Empire is called for; and such organisation will cost money. We must maintain balance. Such effort does not preclude the migration of thousands of men who will not go upon the land, but it will be fatal if the agricultural side be overlooked. Christopher Turnor.

Stoke Rochford,
Grantham, May 31.

The main criticism contained in the article in Nature of May 14 was that the report of the Overseas Settlement Committee did not deal with those very points on which members of Parliament should be informed. The report should have contained the information given in Mr. Turnor's interesting letter, that the Dominions cannot at present absorb all those of our people willing to migrate, and that New Zealand absorbs, per head of population and *pro rata* for her area, more migrants than any other Dominion. Possibly there would be some difficulty in attempting to deal with certain of the factors enumerated in these columns which influence overseas settlement, but most of them could be dealt with—in particular, the inter-relations between overseas settlement and trade with the Dominions, and the programme of development and other development projects put forward by the Dominions which must at some time have been discussed by the Committee. We cannot altogether agree with Mr. Turnor that it is inexpedient to deal with the causes operating against the migration of our peoples to South Africa. They are not sufficiently well known to members of Parliament. Mr. Turnor suggests that migrants of other nations do not receive financial assistance. Possibly foreign Governments do not give direct assistance, but it is a fact that one of the principal objects of the 'Deutsche-Kolonialgesellschaft' is to afford financial support to German emigrants. With Mr. Turnor's concluding sentences we are in entire agreement. That is why regret was expressed that the report did not deal adequately with problems which face the Committee.

The Writer of the Article.

Measurement of Evaporation of Sea Water.

Many methods have been devised for the investigation of the evaporation of sea water, but of them all only those can be applied aboard a ship in which errors caused by the rolling of the ship are prevented. Therefore the method invented by Dieulafait and modified by Penck and Merz has largely come into use. The authors mentioned measured the quantity of evaporated water by observing an increase of the concentration, or density, of the salt solution.

Evidently, however, such an increase must always be very small, because the concentration itself of the salt in the sea water is usually equal to 30-37 per thousand. For example, Merz and Wüst were obliged to wait 12-24 hours before it was possible to make a good observation of the increase of concentration. During such a long time all the meteorological conditions may be altered and the temperature of the evaporating water will change.

The simple method which I describe here is free from all these defects. It is based on the observation of the *cooling* of water caused by evaporation.

The sea water must be poured into a so-called Dewar vessel of a special form, represented in Fig. 1.

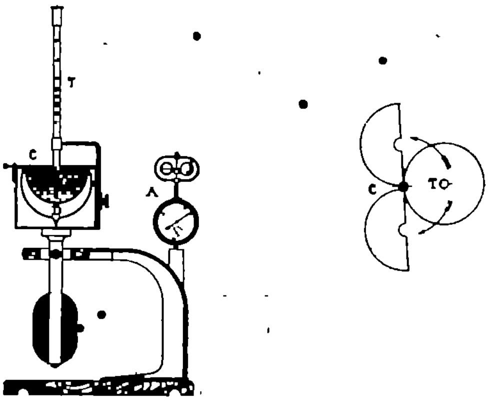

Fig. 1.

The thermometer T gives the initial temperature, when the instrument is closed with a cover C. When the latter is opened the water will begin to evaporate through the action of the wind blowing over its surface. The latent heat of evaporation, specific heat of water, the volume of the vessel, and the area of the water level are known. It is easy, therefore, to calculate the quantity of water which evaporates in 1 sec., per unit area, but only if the mean temperature of the water—before and after evaporation—is equal to that of the air. The interval of time sufficient for the perceptible cooling of the water usually *does not exceed a few minutes*, the thermometer scale showing not smaller parts than fifths of a degree.

The temperature of water is usually higher than that of the air. In such cases one must draw the curve of cooling (Fig. 2). The ordinates of this diagram represent the temperature of the water, and abscissæ either the time or the "distance which the air-particles travelled in the wind." This latter case occurs when the velocity of the wind varies strongly during a short period of time. (For further details on this question see my article mentioned below.)

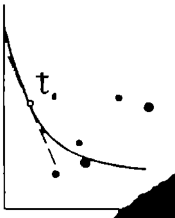

Fig.

We will now consider only the case of constant velocity of the wind. Let us denote the temper
water by t (t_0 being the temperature of
the time by T. Then it is evident
of evaporation is proportional to dt/dT,
point of the curve, where $t = t_0$. To the sa
$(dt/dT)_0$ is proportional the quantity of hea
lost by the water. If we calculate analogous

for other points of the curve (in Fig. 2), we shall obtain data for the study of the *thermal interchange* between the sea and the air: if the temperature of the former is greater than that of the air, there will be a more rapid cooling of the water; conversely, the cooling down will be retarded. From such observations can be deduced the law of thermal interchange, a law of very great importance for geophysical problems.

A great number of observations have been made by me from the Black Sea, over the Mediterranean, Red Sea, Indian Ocean, to the China and Japan Seas, from July 1925 to March 1927. The results of the measurements of the evaporation and thermal interchange will appear in *Gerlands Beiträge zur Geophysik*. The instrument used for these measurements was suspended on Cardan-rings, as is shown in Fig. 1, *A* is the anemometer, placed on the same level with the water in the vessel.

With an analogous instrument one can measure the evaporation of water immediately from the level of the sea or of the lake; in this case it must float in the water so that the edges of the Dewar vessel just touch the water-level. Thus it is possible to find the connexion between the evaporation from a vessel on board a ship and the evaporation in natural conditions.

It is understood, of course, that such experiments can be made only when the water is sufficiently calm.

Was. Shoulejkin.

Physical Institution,
3 Miusskaja 3, Moscow.

Transmission of Heat through a Brick Wall.

The letter on "Solar Radiation and Diathermancy" in Nature, Mar. 26, 460, seems worthy of comment. Radiation, which Mr. Dufton thinks must be called into account to explain the rapid transmission of heat through a brick wall as shown by his curves, is, of course, a possible factor in heat conduction. It appears to us, however, an unlikely one in this case, so we have tried some calculations on the transmission to see if it cannot be explained on the basis of ordinary conduction, assuming reasonable values for the thermal constants.

Fortunately for the purposes of calculation a ladder has, by its shadow, impressed upon the curves at one point a very fair sine periodicity (period T about 1650 seconds), and the velocity V with which the maximum or minimum phase penetrates into the material can be computed. The thermal diffusivity (conductivity divided by product of specific heat and density) is connected with V and T in this case by the relation $V^2T/4\pi$. V may be determined by plotting maxima and minima against time. The points up to a quarter of the whole thickness give a very fair straight line, and even the total thickness curve gives points on the same line if a reasonable assumption is made in identifying corresponding maxima. The half thickness curve does not fit at all, but little weight is given these two latter curves as, strictly speaking, the simple theory does not apply so well to them.

The average velocity comes out 0·0072 cm./sec., which gives a diffusivity of 0·0068 c.g.s. units. This within the range 0·005 to 0·007 usually found for Accordingly we feel that, while there are s about some of the curves which require nation, there is no good reason for ther than ordinary conductivity conunting for the penetration.

L. R. Ingersoll.
John Bardeen.

y of Wisconsin,
on, Wis., May 7.

A New Type of Primary Cell.

With reference to the new type of primary cell described by Jindal (Nature, April 30, p. 639), a description of a two-fluid 'oxidation' cell recently constructed by me may prove interesting.

Zinc, in a saturated solution of ammonium sulphate, and carbon, in an acidified solution of potassium permanganate, form the constituents. In order to maintain the permanganate solution saturated, a layer of the crushed salt is placed at the bottom of the containing vessel.

This cell has an E.M.F. of 2·16 volts, with an internal resistance of 0·5 ohm approximately, for currents varying from 0·6 to 0·2 ampere.

On a simple test, with continuous discharge for twenty hours, the output remained constant for eight hours at 0·3 ampere, afterwards decreasing to 0·2 ampere.

At the conclusion of the test the initial E.M.F. was quickly reached.

Practically no polarisation occurs, and the amount of zinc dissolved is inappreciable.

The cell possesses many advantages over the Daniell elements used in laboratories, and should prove useful, in a modified form, as a source of high tension supply in wireless work.

D. R. Barber.

Department of Physics,
University College, Exeter,
May 13.

The Industrial Revolution.

Miss Buer's letter in Nature of May 7 removes the difficulties which I felt in accepting the reviewer's statement that the rise and population in England after 1750 was due to the introduction of inoculation and a consequent decline in infant mortality.

I am, however, mainly interested in the industrial history of Great Britain in the first half of the eighteenth century, and here I still think that Miss Buer has underestimated the influence of the Colonial trade upon developments in the west of England. In her chapter on commerce Miss Buer says that "Bristol and Norwich were stationary and Liverpool had hardly begun to be." The chroniclers of Bristol (Nicholls and Taylor, for example) do not support this statement. Bristol, it would appear, had been growing in importance long before 1750, and this prosperity had extended beyond the City walls. In 1756, Dean Tucker estimated that the proportion of iron manufacturers—that is, smiths to iron-makers—was two thousand to one. The former were using largely American bar iron, but the iron industry had already moved from the Weald to the west to be in a position to supply this growing market. Hence it is probable that there was in the first half of the eighteenth century a considerable redistribution of population in Great Britain—some depopulation by the southern counties being more than offset by an increase in the western area.

E. Wyndham Hulme.

Old House,
East St., Littlehampton.

A Convenient and Rapid Method of Sampling.

In a recent investigation carried out by the writers, with Mr. E. B. Wedmore (see paper read before the Institution of Electrical Engineers on April 7, entitled "A Contribution to the Study of the Number of Tests required to establish the Rupturing Capacity of an Oil Circuit Breaker"), it was desirable to perform some sampling of a population of Pearson's Type I. As the method used is a simple one and apparently new, and appears to give satisfactory results, a description of it may be of interest.

A stout cardboard disc was accurately subdivided into a number of sectors, such that the angle of each sector was proportional to the number of individuals of the smoothed population corresponding to each of the equal steps of the independent variable. The disc was then pinned down by its centre on top of a cardboard washer and spun rapidly. While still spinning so fast that the markings were indistinguishable, it was stabbed with a sharp instrument and brought to rest. The value attached to the stabbed sector was then noted.

As to the rate of sampling, once the disc is made up, at least 500 samples can be taken in this way per hour per person, using the left hand for spinning and stabbing.

Chas. E. R. Bruce.
W. Bevan Whitney.

The British Electrical and Allied Industries
Research Association,
36 and 38 Kingsway, London, W.C.2,
May 12.

The Occurrence of Indium in Tin.

Mr. M. W. Garrett has recently reported the general occurrence of traces of indium in tin (Nature, Feb. 12, 1927, p. 260). I wish to confirm this observation, which was also made here last January in the course of some other work.

Indium was then detected spectrographically in three samples of tin, and of a number from varying sources since examined only four were found free from it. These included two specimens containing 98·94 per cent. and 97·60 per cent. tin, probably of Chinese origin, the leady 'RBW' brand from electrolytic detinning of tinplate scrap, and the extremely pure 'Chempur' brand (99·998 + per cent. tin). All 'English' brands tested showed strong traces of indium.

Several varieties of soft solder gave a positive result also, and in both tin and solder the most persistent line was found to be $\lambda = 4102$, the next in persistency being $\lambda = 4511$, in agreement with Garrett's result in the case of tin, and contrary, as he has remarked, to de Gramont's.

Indium does not appear to be recognised at all as an impurity in tin. The almost complete neglect of spectral methods of analysis by metallurgists and others may explain this, as the line at 4511 is close to the strong tin line at 4525, and can scarcely fail to be noticed if present.

J. R. Green.

The Laboratory,
Batchelor, Robinson and Co., Ltd.,
Nevill's Dock, Llanelly,
May 13.

Sand-flies and Kala-azar.

In the issue of Nature dated Mar. 26, p. 460, there is a letter from the Kala-azar Commission of the Royal Society working in north China in which the claim is made that for the first time an infection with kala-azar has been produced by means of the intraperitoneal inoculation of the midgut contents of the genus Phlebotomus into an experimental animal.

As the letter is dated Jan. 28 the mistake is a natural one, since the writers cannot then have seen the report of a similar and earlier experimental success on the same lines obtained by the Indian Kala-azar Commission in Assam. The report of this experiment, in which a white mouse was infected with kala-azar by the intra-peritoneal inoculation of the alimentary canal contents of *P. argentipes* infected by feeding on kala-azar cases, was published in the Jan. 1927 number of the *Indian Journal of Medical Research*, but was actually received for publication on Sept. 6, 1926. The fact that the workers in China were working with *P. sergenti var.* and the hamster *Cricetulus griseus*, while the Indian Commission was working with *P. argentipes* and the white mouse, does not affect the question of priority at issue.

H. E. Short.
(Director.)

Kala-azar Commission,
Shillong, Assam, India,
May 14.

Early Suggestion as to the Vacuum Flask.

The following extract from "Mechanical Inventions and Suggestions," by Lewis Gompertz, may interest some readers of Nature:

"Suggestion to produce a Fire-proof Box.

"That this suggestion would succeed, I am far from trusting to, but as possibly it might to some extent do so, it may not be amiss to describe it untried. The box is made of steel, etc., highly polished, as polished metals reflect back the heat as well as the light that are cast upon them. This box is then put into a much larger air-tight case of iron, and has legs of thin wire to prevent it touching the outside case, and all the air is pumped out so as to leave a vacuum between the two boxes, and so that no heat can be conveyed to it by the contact of air; and as the radiant heat is rendered harmless by the polish, and the heat of contact is prevented by the vacuum, it seems that the heat is kept out entirely, excepting through the small wire legs."

The book, which is a second edition, unfortunately bears no printed date, but was given to me in 1856. Lewis Gompertz was secretary to the Animals' Friend Society about 1840.

Richard Inwards.

6 Croftdown Road, London, N.W.5,
May 15.

The Hythe Skulls.

In a recent number of *Biometrika* (vol. 18, p. 22) Miss Hooke writes that the measurements which I made upon the well-known skulls at Hythe were "made on 590 crania selected from at least double that number." The impression which this gives, and actually has given, is that, out of a large number, half had been selected or chosen for some special reason, and that, therefore, probably they did not fairly represent the whole collection. The skulls were in no way 'selected,' but I had measured all which were available at the time, though more have since been recovered.

Miss Hooke says that she believes that these we [illegible] skulls of Kentish people, while the whole of my [illegible] shows that they were those of brachycephali[illegible] grants of the Alpine race who had sett[illegible] probably quite peacefully, in or bef[illegible] century.

The work on the Hythe sku[illegible] quoted by anthropologists that [illegible] correct what I regard as a serious [illegible]

St. Thomas's Hospital,
London, May 5.

The Beginnings and the Early Spread of Agriculture.[1]

By HAROLD J. E. PEAKE.

FOR hundreds of thousands of years, man depended for food and clothing upon the products of the chase. As the last northern ice-cap retreated, Upper Palæolithic man hunted big game on the tundra and cold steppe that lay outside it. Then, as the ice-cap diminished, the zone of open country contracted, and first a coniferous forest, followed by a deciduous forest, occupied the temperate latitudes. Oak forests covered the greater part of these regions in late Magdalenian times, causing big game to become scarce and to retreat to such open lands as were left.

Thus ended the Palæolithic Age. During the Epipalæolithic Age that followed, small isolated communities lived by the shores of the sea, or of lakes and rivers, feeding on birds, fish, and molluscs, supplemented by nuts, berries, and roots. These were hungry times, and it seems likely that some had recourse to collecting wild grass-seeds, as do the natives of Queensland to-day.

Some Epipalæolithic man, or probably one of his woman kind, having collected the seeds of some grass, ancestral to modern grain, must have cast some of these on an open patch of soil and noted that fresh and sturdier plants arose on the spot; a repetition of this process constituted the first advance in agriculture. To ascertain where and when this happened, we must discuss the grains now in use and the places where they occur wild.

The countries in which rice is now grown are known to have received their civilisation from areas long acquainted with the cultivation of wheat and barley. A species of millet, *Panicum colonum*, was used at an early date in Egypt, but it may have been collected from wild plants. *P. miliaceum*, the millet now cultivated, was first grown in south Russia at a much later date. Rye was a common weed in fields of wheat, and in high altitudes supplanted the crop. Oats are a northern crop, and the first evidence of the cultivation of this grain comes from an early Iron Age village in Wiltshire. Barley and wheat have been cultivated from a very early time, though it is not clear which grain was grown first. It is obvious that both must first have been cultivated where they occur wild.

Wild barley is found in south-west Asia, it has been found also in two places in Tripoli. It may once have grown wild along a strip of north Africa from Palestine to the Gulf of Gabes. Wheats are of many species, but may be divided into three ps: einkorns (*T. monococcum*) with 7 chromo- emmers (*T. dicoccum*, etc.) with 14, and (*T. vulgare*, etc.) with 21. Wild *oides*) is found throughout Asia ; it occurs also in parts of nd southern Yugoslavia. Wild *des*) occurs from Mount Hermon and the Anti-Lebanon to the mountains of Moab, east of the Dead Sea; a claim has been made for its occurrence farther east, on the borders of Persia. The origin of the bread wheats is uncertain; they are thought to be hybrids, but whether of *T. dicoccoides* and an Ægilops, an unknown Triticum and an Ægilops or *T. dicoccoides* and *T. ægilopoides* is uncertain. At one place only are both emmer and einkorn found growing wild together; this is on the slopes of Mount Hermon, near Damascus, where Aaronsohn found both growing with wild barley.

There is, however, a school of thought which claims that there was corn in Egypt before it was known elsewhere. This school is championed by Prof. Elliot Smith. Since no form of wheat is known to have grown wild in Africa, the claim is made that barley, which, as we have seen, occurs wild near the north coast of that continent, was first cultivated by the banks of the Nile.

Between 1901 and 1903, Mr. Lythgoe, under Dr. Reisner's directions, explored a predynastic cemetery at Naga-ed-Dêr; this is known as cemetery 7000. No account of the contents of these graves has yet been published, but short references to the cemetery occur in "The Early Dynastic Cemeteries of Naga-ed-Dêr" and in "The Archæological Survey of Nubia." From the latter it would appear that Dr. Reisner has divided the predynastic graves which he has found into three categories—early, middle, and late—and that the graves of cemetery 7000 were early and middle predynastic.

Elliot Smith examined the bodies from these graves, and submitted the contents of the stomachs of a number of them to Dr. Netolitzky, who reported in a letter that several of them contained husks of barley. In two papers that he published shortly afterwards he stated that the glumes were either those of wheat or barley, but later he passed on the material to a pupil, Dr. Hedwig Gherazim, who finally proved that the glumes were those of barley. This proves that these predynastic Egyptians ate barley, and presumably cultivated it, but, as Percival has pointed out in NATURE, since the glumes of wheat do not adhere to the grain, they may have eaten that too.

The predynastic period is a long one, and it is important to know to what part of it these graves belong. Though no dates for this period are available, Sir Flinders Petrie has invented an ingenious device for zoning it. This is the system of sequence dates, which is accepted by nearly all Egyptologists except Dr. Reisner. These sequence dates run from 30 to 78, and the period is usually divided into early S.D. 30–39, middle S.D. 40–59, and late S.D. 60–78. It is not clear that these agree exactly with the corresponding divisions of Dr. Reisner.

Now about S.D. 40 there appears a number of objects not met with in earlier graves; notably

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lectures delivered at the Royal Institution on pear-shaped mace-heads and wavy-handled pottery. Both of these occur in Palestine, and the former are found in very early deposits in Mesopotamia. The inference is that invaders from Palestine had brought in these new objects; they might also have brought with them the knowledge of wheat and barley.

Dr. Hrozny, quoting Schäfer, states that Legrain and Lampre found barley and emmer in a tomb with a contracted burial at Silsileh, without a trace of copper. I cannot find an account of this grave, for de Morgan, who mentions the cemetery, says nothing of grain. Schulz, however, says that the grain was barley, and not emmer, as had been thought.

At Abydos, Prof. Peet found kilns for drying grain, and in them some carbonised matter from which Prof. Harvey Gibson extracted grains of wheat. In similar kilns near by, Peet found pottery fragments belonging to the middle predynastic period. At Badari, Miss Caton-Thompson found grain, identified by Percival as emmer, in a ruined hut; above this hut was a layer of late middle predynastic pottery. In a grave at Hemamieh, between Qua and Badari, Brunton found grain, also identified by Percival as emmer; the pottery, he tells me, is rough and not very typical, but he places this between S.D. 37 and 44. He adds: "A slate, a disk-shaped mace-head, and a stone vase would all be round about S.D. 40."

The evidence of these three discoveries tends to show that wheat arrived in Egypt in S.D. 40, and was freely used early in the middle predynastic period. Whether barley was grown earlier depends on whether the graves in cemetery 7000 at Naga-ed-Dêr and that at Silsileh date from before this time. In the absence of details as to the grave contents this must remain for the present an open question.

Thus it would appear that wheat certainly, and perhaps barley too, were first cultivated in Syria, probably on the slopes of Mount Hermon. In this connexion it is well to remember the statement of Diodorus Siculus, written 2000 years ago, that the Egyptian goddess Isis discovered "wheat (πυρός) and barley growing promiscuously about the country along with other plants, and unknown to mankind," and that this occurred at "Nysa, a high mountain in Phœnicia, far away."

As we have seen, emmer was taken to Egypt at the beginning of the middle predynastic period; thence this grain appears to have been carried to the lands surrounding the Mediterranean. Grain was also cultivated early in Mesopotamia, though which grain was known there first is uncertain.

Before 2000 B.C. the Sumerians compiled lists of kings and dynasties, beginning with eight or ten antediluvian monarchs, who ruled at various cities in Mesopotamia. One of these kings reigned at Eridu, while another, who ruled at Suruppak, escaped in a boat from the flood. After the flood there ruled in succession dynasties at Kish, Erech, and Ur. A tablet found near Ur mentions A-annipadda, son of Mesannipadda, the founder of the first dynasty of that city, and quite lately a lapis lazuli cylinder seal of Nin-Kur-Nin, Mesannipadda's queen, was found in a grave at Ur. No search has yet been made for relics of the first dynasty of Erech, but at Kish, Prof. Langdon has found a layer which he believes dates from the first dynasty of that city, the first after the flood. Here have been found tablets covered with pictographic inscriptions and also some pots of a polychrome ware.

Similar polychrome pottery was found last year at Jemdet Nasr, about 16 miles from Kish, and in one of these pots some grain, which is clearly a kind of wheat. Unfortunately, experts differ as to the species. An American botanist has identified it as *T. vulgare*, Dr. Stapf believes it to be *T. compactum*, a more developed type of *T. vulgare*, while Percival states that it is *T. turgidum*, a more developed type of *T. dicoccum* or emmer. Whatever may be the ultimate verdict, it is clear that wheat of some kind had long been cultivated in Mesopotamia at the time of the first dynasty of Kish.

At Tell el Obeid, however, graves have been found which are believed to antedate the first dynasty of that city by a long time; they contained fine painted pottery. Similar pottery, sickles, hoes, and querns, and pear-shaped mace-heads, have been found at Abu-Shahrein, the site of Eridu, the seat of one of the antediluvian monarchs. It is clear that grain was grown in Mesopotamia before there took place the disaster which gave rise to the story of the Great Flood.

At a very early date people making highly burnished pottery had been living at Knossos in Crete; their figurines suggest that they came from Asia Minor. No evidence of agriculture has been found among their remains, but if they cultivated grain it is likely to have been einkorn, which is native to Asia Minor. About 3400 B.C. fresh people arrived on the Mesara Plain; these Sir Arthur Evans believes came from the north-western corner of the Delta. Though there is again no evidence of agriculture among the remains found of these people, they can scarcely have been ignorant of the practice, and probably cultivated emmer. It seems likely that it was the Cretans who disseminated this grain throughout the Mediterranean area.

Other people from south-west Asia Minor were working the mineral resources in the Cyclades about the same time, and a few centuries later settled in Argolis and near Corinth. It is thought that these people grew grain, and if so it is likely to have been einkorn. Other people, also from Asia Minor, settled still earlier in Thessaly. These are known to have grown grain, though of wh [illegible] type is uncertain; again it seems likely that it [illegible] einkorn. A third set of people, prob [illegible] Asia Minor, came apparently by boa [illegible] Danube basin, and settled near th [illegible] deposits of Hungary and Tran [illegible] likely that they had arrived th [illegible] before 3000 B.C. Einkorn h [illegible] of their settlements.

Lastly, we have the Black Earth lands of south Russia, in which we have evidence of a civilisation, the first stage of which is thought by most people to be coeval with those mentioned in Thessaly and the Danube basin. This civilisation is distinguished by a profusion of painted pottery, and evidence that the people who made it were grain growers. According to Prof. Childe, this civilisation was destroyed about 2600 B.C., when some of the people fled to Thessaly, inaugurating there the second Thessalian civilisation. The destroyers seem to have been nomads from the steppes east of the Dnieper; these seem to have invaded the Danube basin, founding there the second Danubian civilisation. Now at Sesklo, a second Thessalian site, and at Lengyel, a second Danubian site, grain has been found; in both cases the sample contains both einkorn and *T. vulgare*. The inference is that both regions grew einkorn during the first phase, and that *T. vulgare* was introduced into both from the Black Earth lands. Quite recently a paper has been published in Kiev, citing the existence of *T. vulgare* from a site near that city, belonging to this culture, though whether this belongs to the first or second phase is uncertain.

At Anau, a village site in Turkestan, painted pottery has been found, bearing some resemblance to that of the Black Earth lands. In the earliest layer on this site were found potsherds containing impressions of grain; this grain has been identified as *T. vulgare*. From this it is suspected that the art of painting pottery and the cultivation of bread wheats both arose somewhere in Transcaucasia.

From Crete and the Danube basin the practice of agriculture spread, by sea and by land, to all parts of Europe, while from Turkestan it was carried, with painted pottery, certainly to north China and most probably also to north-west India.

Television.

By Prof. E. Taylor Jones, University of Glasgow.

On May 24 and 26 I proceeded, at the invitation of Mr. John L. Baird, to the Central Station Hotel, Glasgow, to witness demonstrations of television between London and this city. I was received by Mr. Baird's colleague, Capt. Hutchinson, who explained that the transmission was to take place over the telephone line, Mr. Baird, in his laboratory in London, being in charge of the transmitting apparatus.

The earlier apparatus devised and used by Mr. Baird has been described by him in the *Journal of Scientific Instruments* for Feb. 1927. A model of the original transmitting apparatus is in the possession of the University of Glasgow, of which Mr. Baird is a former student. The following additional information as to the method has been supplied by him:

"The method used in the London-to-Glasgow demonstration consisted in passing an image of the object being transmitted over a light-sensitive cell in a series of strips. The modulated current from the cell was transmitted over the ordinary trunk telephone line, and at the receiving station in Glasgow was used, after amplification, to control the light of a glow discharge lamp, a modified form of neon tube, giving a light of intense brilliance, being employed. By means of a revolving slotted shutter a point of light from this lamp was caused to travel over the field of [illegible]ion in exact synchronism with the traversal of [illegible]age over the cell at the transmitting station, [illegible]raversal taking place in about one-[illegible]ond."

[illegible]paratus was set up in a semi-[illegible]ne lamp and shutter being [illegible]vided with an aperture. The [illegible]he aperture saw at first a [illegible] in which the luminosity appeared to travel rapidly sideways, disappearing at one side and then reappearing at the other. When any object having 'contrast' was placed in the light at the sending end, the band broke up into light and dark portions forming a number of 'images' of the object. The impression of sideway movement of the light was then almost entirely lost, and the whole of the image appeared to be formed simultaneously. The image was perfectly steady in position, was remarkably free from distortion, and showed no sign of the 'streakiness' which was, I believe, in evidence in the earlier experiments.

The size of the image was small, not more than about two inches across when the 'object' was a person's face, and it could be seen by only a few people at a time. The image was sufficiently bright to be seen vividly even when the electric light in the room was switched on, and I understand that there is no difficulty in enlarging the image to full size. I was told also that arrangements will soon be made for transmitting larger 'objects,' and for increasing the number of appearances of the image per second.

The amount of light and shade shown in the image was amply sufficient to secure recognisability of the person being 'televised,' and movements of the face or features were clearly seen. At the second demonstration some of those present had the experience of seeing the image of Mr. Baird transmitted from London while conversing with him (over a separate line) by telephone.

My impression after witnessing these demonstrations is that the chief difficulties connected with television have been overcome by Mr. Baird, and that the improvements still to be effected are mainly matters of detail. We shall doubtless all join in wishing Mr. Baird every success in his future experiments.

The Forthcoming Eclipse.

Excursions and other Railway Arrangements.

London and North Eastern.

The London and North Eastern Railway (King's Cross Station, London, N.1) is running the following excursions in connexion with the eclipse:

(*a*) June 28. King's Cross, dep. 9.50 P.M.
Peterborough, dep. 11.28 P.M.
Grantham, dep. 12.7 A.M. (June 29).
Newark, dep. 12.28 A.M.
Retford, dep. 12.54 A.M.

arriving at Richmond, Yorkshire, at 3.42 A.M., returning from there at 10.55 A.M., due York, 12.25 P.M., a stop being made to give passengers an opportunity to look round York. The train will leave York at 3.45 P.M., due Retford 4.57 P.M., Newark 5.22 P.M., Grantham 5.43 P.M., Peterborough North 6.20 P.M., and King's Cross 7.55 P.M. Restaurant cars will be provided, and arrangements are being made to serve refreshments to passengers in the train after the eclipse and before the train leaves Richmond, in addition to meals *en route*.

(*b*) From Marylebone, leaving about 9 P.M., calling at Amersham, Finmere, Rugby, Leicester, Loughborough, Nottingham, and Sheffield to Richmond, returning on the morning of June 29, with a stop of a few hours at York, arriving at Marylebone in the evening. Buffet cars will be provided to serve light refreshments.

(*c*) From Colchester about 7.30 P.M., with bookings from Cambridge (via Ely or Bury St. Edmunds), Ipswich, Bury St. Edmunds, Thetford, Ely, March, Spalding, Sleaford, Lincoln, Gainsboro' Lea Road, and Doncaster, returning from Richmond on the morning of June 29, time being allowed for a few hours at York.

London, Midland and Scottish.

Special restaurant excursion trains are announced by the London, Midland and Scottish Railway (Euston Station, London) to Southport, which is on the centre line of totality.

A cheap excursion to Southport will leave Euston at 11.10 P.M. on Tuesday night, June 28, and supper will be served on this train. Passengers will return by the 8.20 A.M. train from Southport (Chapel Street) on Wednesday, June 29, on which train breakfast will be served.

Another cheap excursion to Southport, with bookings for 2, 5, and 8 days, will leave Euston at 11.12 A.M. on Tuesday, June 28. Luncheon will be served on the outward journey on June 28 and on the return journey on June 29.

Excursion bookings from certain provincial towns are also being given to Southport, Settle, Llandudno, Colwyn Bay, Rhyl, St. Annes, and Blackpool.

In addition, period bookings will be given on Tuesday, June 28, returning on three specified dates, to stations on the North Wales coast from Manchester, Liverpool, and Lancaster and Yorkshire districts generally, also to Carnarvon and Llanberis from Manchester and Liverpool districts and Chester. Similar bookings will also be given to Southport—Blackpool from stations in Lancashire and Yorkshire.

A special train for the Institution of Civil Engineers is leaving St. Pancras for Settle on June 28, and one for a Stowe Public School party is leaving Buckingham for Rhyl on the same evening.

Great Western.

The Great Western Railway (Paddington, London) announces that a liberal programme of day and period excursion bookings has been arranged to Criccieth and other North Wales resorts for the eclipse from principal stations on its system.

A special train will leave Paddington Station on Tuesday evening, June 28, by which cheap bookings will be given from London, Reading, Oxford, and other principal stations on the G.W.R. route to the north. Day trips will also be run from Cardiff, Bristol, Gloucester, Cheltenham, Worcester, etc., and from the Wrexham District.

Period excursions will also be run from the west of England on Monday night, June 27, and from other principal G.W.R. stations on June 28, enabling passengers to return on June 29, July 2, or July 4.

Obituary.

We record with regret the death of Prof. John Bagnell Bury, Regius professor of modern history at Cambridge, which took place at Rome on June 1. Born in County Monaghan on Oct. 16, 1861, he entered Trinity College, Dublin, as a sizar, and was elected to a fellowship in 1885. After his election he began to specialise as a historian, publishing his "History of the Later Roman Empire from Arcadius to Irene" in 1889. In 1893 he was appointed professor of modern history in the University of Dublin, and in 1902 he succeeded Lord Acton as Regius professor at Cambridge. He had already published his most important and lasting work, in his "History of the Roman Empire from its Foundation to the Death of Marcus Aurelius" (Murray's "Student's Histories," 1893), the "History of Greece to the Death of Alexander" (1900), and his edition of Gibbon (1896–1900). In these, his remarkably [illegible] range of knowledge, his extensive acquaintan[illegible] languages, his ability to marshal a vast [illegible] and his scientific conception of hist[illegible] to the full in a treatment of hist[illegible] combined a broad grasp of th[illegible] a scrupulous care for detail. [illegible] published work, he was resp[illegible] Cambridge "Medieval His[illegible] the editorship of the Cambr[illegible]

News and Views.

How experimental research carried out on dogs has benefited both that animal and man is described in the Memorandum of the Medical Research Council on the Dogs Protection Bill now before Parliament. Recent advances in knowledge have been made by this means in the study of rickets, disorders of the teeth, diseases of the heart and circulation, and in diabetes, as well as in distemper and various types of jaundice prevalent among dogs. The proof that rickets is a dietary disease and can be cured by changing the diet, so as to supply an adequate amount of the anti-rachitic vitamin, was first obtained by feeding experiments carried out on puppies. An unexpected outcome of these experiments was the discovery that absence or deficiency of this vitamin in the diet prevents the proper development of the hard enamel of the teeth: this work is still in progress, and may lead to the prevention of dental decay in human beings. The control of diabetes by the use of insulin, which has been such a boon to sufferers from this disease, was made possible by experiments on dogs: in fact the whole of our knowledge of this disease from the time of the discovery of the relation of the pancreas to diabetes to the discovery of insulin has been gained by experiments on this animal. Nor must the benefits to the dog itself from experimental research be forgotten: protection against distemper is already becoming practicable, as also against the spirochætal jaundice which is not uncommon in Great Britain and often fatal, whilst a cure has been found for the malignant jaundice or piroplasmosis of dogs in the injection of the dye trypan blue.

It is the considered and unanimous judgment of the Medical Research Council that the proposals of the Dogs Protection Bill would place an insuperable and permanent barrier across some of the chief paths of progress in medical research. The memorandum describes the reasons which make the use of dogs for experimental purposes necessary, and gives in some detail results which have been, or are being, obtained from such experiments. Considerations of size are frequently important: practicable alternatives to the dog are the sheep, pig, goat, or ape, but none can be kept completely healthy and comfortable in the laboratory except the dog. Moreover, its long domestication has assimilated its natural diet to that of man, and many of its bodily structures provide the nearest approximation among animals to those of man, so that results of experiments, both dietary and pharmacological, can often be applied directly to the case of human beings. The special habituation of [illegible] dog to man's presence is also in favour of its use, [illegible] is less terrified by the near approach of human [illegible]ther less domesticated animals. On the [illegible] memorandum points out that the dog [illegible] other smaller animal is available, [illegible] minority of experiments are [illegible] knowledge which has been [illegible] nts forms part of the every- [illegible] physician or surgeon, and [illegible] includes the foundations of the physiology of the digestive and circulatory systems. To avoid the danger of the use of stolen dogs for purposes of experiment, the Council recommends that the Dogs Act, 1906, be amended to allow of the use of some of the 50,000 animals annually destroyed in London alone. These dogs are those which either have no owner or whose owners do not care enough about them to make inquiries when they are lost. It would allow part at least of the now useless annual massacre of dogs to be turned to the permanent advantage of mankind and of other animals.

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The forthcoming total eclipse of the sun affords radio amateurs an excellent opportunity of experimenting on the effects produced by the eclipse in preventing the sun's rays passing through part of the conducting layer in the upper atmosphere. The shadow cast by the moon will pass through the reflecting surface of this layer at approximately 100 miles south-east of the path of the visible eclipse. During the eclipse, the layers over a broad band of the country between Cardiff and Grimsby will be a band of totality for radio observations. In the *Wireless World* for June 8, Prof. E. V. Appleton gives a popular description of the phenomena that are likely to happen, and offers useful advice to all who desire to attempt to record them. Observations, he says, ought to be confined to the broadcasting range or even to waves of shorter wave-length. These will probably give indications of the phenomena associated with sunrise and sunset after the normal sunrise has taken place. The observations made on the day of the eclipse will, however, be of little value unless they can be compared with the results normally obtained. Hence observations of a similar character should be made at least on the morning before, and on the morning after the day on which the eclipse occurs. Observers should choose a station the signals from which they can receive with great ease, and make a special study of the sunrise and sunset characteristics of these signals. They will, therefore, only have to note if any extra phenomena are observed on the morning of the eclipse. It is important to time each observation correctly with a watch or clock checked before and after the series of observations by means of time signals. It should also be recorded whether the times given are in British summer time or Greenwich mean time.

The Halley Lecture on "Modern Eclipse Problems," delivered by Mr. F. J. M. Stratton on May 20 and just published by the Clarendon Press, Oxford, at 2*s.* 6*d.* net, provides a comprehensive and clear account of investigations, carried out and contemplated, into the nature of coronal light and related matters. Chief attention is rightly devoted to these subjects, because it is only during the brief period of a total eclipse that the corona can be studied spectroscopically or its form be portrayed. As Mr. Stratton remarks, "The question of the source of the coronal light, particularly in the lower levels, remains a very open one, and steam formed, all the hydrocarbon being burnt to carbonic oxide and hydrogen, leaving the original hydrogen intact.

(2) That in *all* the complex ethylene-hydrogen-oxygen or methane-hydrogen-oxygen (or -air) mixtures examined by us, which were formed by blending a hydrocarbon-oxygen (or -air) mixture (*A*) with a hydrogen-oxygen (or -air) mixture (*B*), both having the same flame speed and both containing oxygen in defect (*i.e.* the respective pairs of primary mixtures numbered 3 to 7 inclusive in the foregoing list) *the effect of progressively increasing the proportion of (B) in the various blendings in each given series of tests was to lower the observed flame speed progressively until a point was reached when the resulting complex mixture no longer propagated flame at all.*

The fact that the flame speeds for (CH_4+H_2)-air mixtures exhibit only small deviations from the supposed 'law' is scarcely relevant to the discussion because of the comparatively small proportion of a hydrogen-air mixture which has to be blended with a methane-air mixture of the same type and speed to produce a (CH_4+H_2)-air mixture containing oxygen in defect, the only condition that really matters. Thus, for example, in the case examined by us, only 13·35 volumes of a 71·9 H_2/28·1-air mixture (flame speed = 64·1) would have had to be blended with 86·65 volumes of an 11·05 CH_4/88·95-air mixture (flame speed = 64·5 cm. per sec.) to produce a (CH_4+H_2)-air mixture with a flame speed of 58 cm. per sec., that is, with a deviation of only 10 per cent. from that required by the 'law' (see Table V. on p. 439 of our paper). When, however, oxygen was substituted for air as the supporter of combustion, a much greater deviation was observed; for, as will be seen from Table IV., p. 437 of our paper, if a 53·2 CH_4/46·5 O_2 mixture were to be blended with a 92·9 H_2/7·0 O_2 mixture so as to form a (CH_4+H_2)-oxygen mixture, the speed of the two primary mixtures (each 114 cm. per sec.) would be lowered in the process to about 88 cm. per sec., or by about 23 per cent. Our experiments also indicated that a series of (CH_4+2H_2)-oxygen (or -air) mixtures (oxygen being in defect) would show even more considerable deviations from the 'law.'

In conclusion, I would add that our experimental examination of the supposed 'law' was undertaken from a sense of duty, and that, having satisfied ourselves that it does not apply to gaseous explosions generally, it has no further interest for us. So, with more important matters to investigate, we do not propose continuing its discussion any further.

William A. Bone.

Imperial College of Science,
South Kensington,
London, S.W.7,
June 3.

The Walrus.

Although the walrus is usually found near the land subsisting on the shell-fish it finds at the bottom, it is also on rare occasions found amongst the drift ice in deep water, far from land, subsisting on seals and other mammals.

A few examples of the latter kind are recorded in the log-books of whaling and sealing voyages to the Greenland Sea in my possession, and several others came under my own observation during voyages to the same locality.

On one occasion (July 1890), when amongst the ice, off the east coast of Greenland, I noticed an unusual number of birds, some oily water, and something floating in it. Lowering a boat, I found it to be a dead narwhal. It was criss-crossed with deep wounds, had its abdomen ripped open and partly eaten away, and its viscera, including most of the liver, removed. It was only recently dead. Hidden from me and my companions in the boat by a high piece of ice, but visible from the mast-head of the ship a mile or two away, a large walrus lay asleep on an adjoining piece of ice. Unaware of this, and considering the narwhal—a female without a tusk—valueless, I returned on board empty-handed, to learn about the walrus and to be told by my father that the ship could no longer be delayed.

On an earlier voyage, before I commenced sailing with him, my father, the late Capt. Gray of Peterhead, came across a narwhal recently dead and a walrus engaged either in killing it or eating it. The facts will be found fully reported in *Land and Water*, December 1879. Briefly, in July 1879, in lat. 78°, long. 3° W., amongst the ice between Greenland and Spitsbergen, my father noticed an unusual commotion in the water, and, on ascertaining the cause, lowered a boat and secured both the walrus and its victim. The body of the latter was scored with deep wounds, and the stomach of the former was packed with its blubber.

On another occasion (June 1887), in lat. 73°, long. 16° W., we saw a walrus in the water with a seal in its mouth. Lowering a boat, we killed the walrus and retrieved the dead seal. The latter, a floe-rat, *Phoca hispida*, was almost cleft in twain by a single wound. On other occasions I have removed portions of seal (bits of skin, blubber and liver) from a walrus's stomach. (Particulars are to be found in the *Zoologist*, 1889, p. 8.)

The solitary animals that we used occasionally to find amongst the ice far from land subsisting in the way described were all of large size, and may well have belonged exclusively to the male sex. In the only two instances in which it is recorded the sex is male; none of them were accompanied by calves; moreover, in the summer months the adult males cling less to the land than the females and immature animals, venture farther afield, and are more likely to be seen far from land. In fact, the old 'bulls' are not to be found in the in-shore waters of Spitsbergen and Franz Joseph Land in June and July (see Allen, "North American Pinnipedia," p. 108, and *Zoologist*, 1895, p. 75).

In Scoresby's time straggling walruses were apparently more frequently seen by the whalers on the so-called 'whaling banks' between Greenland and Spitsbergen. In his "Arctic Regions," vol. 1, p. 508, we read of a single ship, while engaged in its quest for whales, picking up as many as half-a-dozen in a single season without approaching either Spitsbergen or Greenland with the express purpose of catching it. This may well have been the case, for it was not until a later date that the Norwegian walrus hunters began to kill them in the in-shore Spitsbergen waters and that it became seriously depleted in number.

R. W. Gray.

11 Hulham Road,
Exmouth, Devon.

Surface Film of Aluminium.

In Nature of May 7, p. 673, I have read with a good deal of interest an account of some experiments made on aluminium foil which had been treated by the Bengough anodic process. In some experiments made on ordinary aluminium foil in connexion with a research on the determination of oxide in aluminium, details of which work was published in the *Jour. Soc. Chem. Ind.*, vol. 45, p. 170, the writer, in collaboration with Miss H. E. Millar, had previously made the same observations as Messrs. Sutton and Willstrop. In our experiments, and employing the same method, it was even possible to notice the film on such thin foil as 0·00075 in. in thickness, and moreover we were able to identify surface markings on the layer which were originally present on the original metal. Messrs. Sutton and Willstrop are probably unaware that we had previously made this observation, and therefore the correctness of our conclusions becomes the more certain.

W. H. Withey.

The National Physical Laboratory,
Teddington, Middlesex,
May 17.

We are glad to have been given the opportunity of reading the letter from Mr. W. H. Withey. We had already read the paper by Mr. Withey and Miss Millar with much interest, and had spent a good deal of time in an attempt to interpret their results. These appeared to us to indicate that the material of their sheet No. 1 was free from both internal and superficial oxide; that rolling sheet 1 down from 0·01 to 0·006 in. in thickness produced a film thicker than that which we have so far found present on aluminium which has stood over long periods exposed to air, and that later rolling reduced the thickness of the film as well as that of the metal to a value much below the normal, assuming equal density of the films.

It appeared to us possible that under the very high pressure exerted by the rolls, the metal may attain a very high temperature locally and oxidise rapidly in the same way in which, for example, steel is known to do in an overloaded ball race, but that the oxide film formed in the early stages of rolling may obstruct further superficial oxidation during subsequent rolling. We do not know whether Miss Millar and Mr. Withey have any further results which would throw light on this matter or whether they would regard this tentative explanation as a reasonable one.

Accepting the results of Miss Millar and Mr. Withey regarding film formation in rolling, of which we have no experience, our experiments have so far indicated that by long standing in air, a surface film is formed of three to five times the thickness of that present on their finished sheet, but at present our experience has been confined to thin sheets. Also, the directly observed increase in weight of aluminium standing in air, recorded by Dr. Vernon in the second report to the Atmospheric Corrosion Research Committee, corresponds to about twice the thickness of film present on the finished sheet of Miss Millar and Mr. Withey, assuming the films to have the same composition.

H. Sutton.
J. W. W. Willstrop.

Metallurgical Department,
Royal Aircraft Establishment,
S. Farnborough, Hants,
May 31.

Etch Planes in Metallic Single Crystals.

It is well known that when an etching solution is applied to a metallic crystal, the action takes place so as to leave the surface 'stepped' in such a way that optical reflection takes place from planes in the crystal which are definitely related to the crystallographic axes. We have investigated this relationship with single crystals of iron, nickel, and aluminium.

The iron crystals were etched with a 10 per cent. solution of nitric acid in alcohol, and the nickel ones with concentrated ferric chloride solution. We have obtained very good etch patterns on aluminium by treating first in caustic soda and then with ferric chloride solution. This process appeared to give a better contrast etch than the ordinary treatment with caustic soda alone.

The apparatus for locating the etch planes by means of the optical reflections consisted simply of a crystal goniometer mounted in place of the prism table on an autocollimating spectrometer. The planes from which reflection takes place can be identified by measuring the angles between different reflecting facets. By setting the crystal so that a zone axis is parallel to one of the goniometer axes, the angle between two reflecting planes can be measured by a single movement of the goniometer.

In the case of iron, which is a body-centred cube, the problem appears quite simple, the etch reflections being mutually perpendicular, indicating that the planes are $\{100\}$. (See also McKeehan, Nature, May 14, p. 705.) The case of aluminium (face-centred cube) is similar, except that in a few cases reflections were obtainable from $\{110\}$ planes. These reflections, however, were always very faint compared with those from $\{100\}$ planes. Although the structures of aluminium and nickel are similar, they etch in different ways. Davisson and Germer (Nature, April 16, p. 558) state that nickel crystals etched by vaporisation develop $\{111\}$ facets. Using the etch method described above, we have found that $\{111\}$ and $\{100\}$ facets are formed, as is shown by the fact that strong reflections were obtained in directions inclined to one another at 90°, 70°, 55°, or the supplements of these angles.

A considerable number of crystals were examined by the optical method and the measured angles were generally within 1° of the calculated values. X-ray examination by Müller's method (*Proc. Roy. Soc.*, 105, p. 500) of a number of nickel crystals gave results in agreement with the optical data. The development of two etch planes does not in any way invalidate the use of etch reflections for the determination of crystal planes, but a more thorough examination of the crystal becomes necessary to avoid ambiguity.

H. H. Potter.
W. Sucksmith.

Physics Department,
The University,
Bristol, May 20.

'Active' Nitrogen.

In all the work, both theoretical and experimental, which has so far been done with regard to active nitrogen, it has at least tacitly been assumed (*a*) that active nitrogen is homogeneous and (*b*) that the afterglow and chemical activity are necessarily co-existent, although from Saha and Sur's theory of the nature of active nitrogen (*Phil. Mag.*, 118, 421; 1924), it follows that nitrogen may be 'active' and yet show no luminosity. Dr. H. W. B. Skinner has recently suggested to the author that in view of the production of H atoms, excited H_2, and H_3 by the discharge in hydrogen, it does not necessarily follow that the form of nitrogen which is responsible for the afterglow is that which is chemically active. Experimental evidence completely in support of this theory has now been obtained.

If a stream of glowing nitrogen be led through a second and weak discharge, the luminosity is destroyed or very considerably diminished, as described by Lord Rayleigh (*Proc. Roy. Soc.*, 92, 438; 1916). The concentration of active nitrogen in the gas stream may be determined by the admission of nitric oxide to the gas below the discharge (Willey and Rideal, *Jour. Chem. Soc.*, 1926, 1804), and it has now been found that when two independent discharges are provided, one strong and producing the afterglow and the other feeble, the gas being led from the former to the latter, the yield of nitrogen peroxide is *greater* with the two discharges than when the stronger is used alone, in spite of the almost complete extinction of the glow by the weaker discharge. Moreover, if the latter be used alone, little or no luminosity is visible in the gas in the exhaust line, but abundant formation of nitrogen peroxide occurs.

It thus appears that the glowing and chemically active forms of nitrogen are distinct from each other, and that the estimates as to the energy of 'active' nitrogen made severally by spectroscopists and Dr. Rideal and myself have really been upon different modifications of this element. The same applies to the respective deductions as to the nature of 'active' nitrogen. While we may now with confidence regard the luminous variety as being due to the recombination of atoms with a heat of formation of *ca.* 250,000 cal./gm. mol., the nature of the other kind, which is apparently the chief constituent of 'active' nitrogen and possesses an energy of *ca.* 45,000 cal./gm. mol. is still somewhat obscure; the choice would appear to lie between metastable molecular nitrogen and a more complex body such as N_3.

A full account of these investigations will shortly be published. **E. J. B. Willey.**

Laboratory of Physical Chemistry,
Cambridge, May 4.

Designation of Thyroxine.

Kendall (*Proc. Am. Physiol. Soc.*, *Am. Jour. Physiol.*, **45**, 540; 1918) named the crystalline compound he isolated from the thyroid *thyroxin*, as an abbreviation for *thyro-oxy-indole*, since he believed it to contain an indole nucleus. Harington has shown that, on the other hand, it is an iodised amino-acid, derived from tyrosine. He has gracefully accepted Kendall's name, merely adding the final *e* necessary for an amino-acid in English terminology.

Nevertheless, from a teaching point of view, a name that signifies something incorrect is undesirable, in spite of numerous examples that persist (the majority of bio-catalysts do not produce a 'boiling' and do not occur in yeast, and are but clumsily, therefore, termed ferments or enzymes; it is doubtful if the majority of 'hormones' 'arouse').

It seems very desirable that Harington, or, if he refuse, some one of the elder endocrinologists, should find a new name for this internal secretion of the thyroid gland which will more accurately suggest its derivation. I would suggest for their consideration a term such as *thyrosine*, or *thyroisine*, either of which practically retains Kendall's name, and at the same time emphasises both the thyroid origin of the compound and its close relationship with tyrosine, the two points which obviously require emphasis.

May I also suggest that stress should be laid on Harington's opinion (*Biochem. Jour.*, **20**, 298; 1926). "In view of the constitution of thyroxine . . . racemisation during the alkaline hydrolysis (of thyroid tissue) is the probable explanation of the absence of optical activity in the product." It seems, by analogy, extremely unlikely that thyroxine, as secreted by the thyroid gland, should be optically inactive; and further, by comparison with adrenine, we may reasonably infer that one of the two optically active isomers will be physiologically completely, or almost completely, inert. If this should prove to be the case, then commercial thyroxine will have but one-half the activity of thyroxine in thyroid, and an explanation may be available for that discrepancy between the physiological activities of thyroxine and of desiccated thyroid tissue that Reid Hunt found by use of his acetonitrile test with mice (*Am. Jour. Physiol.*, **63**, 257; 1923); my own experiments, utilising growth and organ-hypertrophy effects on rats (*Trans. Roy. Soc. Canada*, **20**, 307; 1926) have supported his conclusion that (*optically inactive*) thyroxine does not represent the full activity of the thyroid gland. **A. T. Cameron.**

University of Manitoba,
Winnipeg, Canada, May 25.

The Calibration of Photographic Plates.

In Nature (May 14, p. 707) Dr. E. A. Baker discusses the calibration curves of photographic plates. The curves he gives certainly show a good agreement in sensitivity between the different batches of plates used under his conditions of standardisation. Concerning the reference to Harvard results (Harvard Circular 302), it may be of interest to note several points not fully discussed in the original paper on spectrophotometric method.

The curves to which Dr. Baker refers are the density curves of ten of the photographic plates analysed in our regular photometric programme, and are representative of the general results obtained. Intercomparison of the curves allows us to examine the effects of emulsion and developer. Curves for plates taken from the same box show no closer agreement among themselves than do those for different boxes of plates coated with the same emulsion. Even plates with two different emulsions show no greater differences from one another than do plates with the same emulsion.

A similar result is obtained with regard to developer. Plates developed with different batches of one developer agree as well as do those from a single batch of developer, while plates developed with one of the two kinds of developer used at Harvard show an agreement among themselves that is little, if any, closer than the agreement for plates developed with the two different kinds of developer.

The idea of the Harvard individual plate calibration curves, however, was not specifically the elimination of differences in emulsion or developer, though this will of course follow. It was to set up a density curve for the plate used, *for the conditions under which it was exposed*, rather than to ensure the constant sensitivity of different plates under carefully standardised conditions. The calibration curves, as described in Harvard Circular 301, will allow for any possible changes in sensitivity due to the temperature and humidity during exposure in the telescope, to the ageing of the plates, or to delayed development, as well as for any loss of transparency of the background and exposed portions of the plate due to sky fog.

Exact agreement between various reduction curves is not to be expected, nor would it have any significance for the spectrophotometric results. Individual plate calibration is at least a safe procedure until such time as a greater knowledge of, and dependence on, the actions of photographic plates under various conditions is obtainable.

Frank S. Hogg.
Cecilia H. Payne.

Harvard College Observatory,
Cambridge, Massachusetts, June 3.

The Spectrum of Ionised Neon (Ne II).

For some time the spectrum of ionised neon (Ne II) has been a subject of investigation in the Amsterdam Laboratory "Physica." The analysis of the F I spectrum, given in former papers (*Verslagen Kon. Acad. Amsterdam*, June 1926, December 1926) and the theory of complex spectra of Heisenberg and Hund formed preliminary steps for the analysis of Ne II. A great part of the Ne II lines have now been classified by me in a term scheme exhibiting a perfect analogy to that of F I. The following table gives an example of this analogy:

F I.				Ne II.							
Term.	*j*.	Term Value.	Term Difference.	Term.	*j*.	Term Value.	Term Difference.	Hund's Theory.	Interval Ratio. Landé.	F I.	Ne II.
a^2P	2 1	135320 134913 (16·6 volt)	407	a^2P	2 1	270000 269220 (33·4 volt)	[780]	$^3P+2_1$			
^4P	3 2 1	58617·0 58342·3 58182·3	274·7 160·0	^4P	3 2 1	117000·0 116482·0 116183·0	518·0 299·0	$^3P+3_1$	1·67	1·72	1·73
$^4P'$	3 2 1	45104·8 44981·9 44879·2	122·9 102·7	$^4P'$	3 2 1	89938·2 89715·6 89533·1	222·6 182·5	$^3P+3_2$	1·67	1·19	1·21
^4D	4 3 2 1	44035·4 43858·8 43714·3 43630·9	176·7 144·5 83·4	^4D	4 3 2 1	87022·7 86684·9 86435·2 86291·1	337·8 249·7 144·1	$^3P+3_2$	2·33 1·67	2·11 1·73	2·34 1·73
^4S	2	42595·0		^4S	2	83178·0		$^3P+3_2$			

The complete term table for Ne II and the lists of classified lines with further details will be published elsewhere.

T. L. DE BRUIN.

Laboratory "Physica,"
Amsterdam, May 24.

The Nomenclature of Chromosome Groups.

IT is well known that several plants and animals have been found which have (*a*) three, four, or more haploid groups of chromosomes, instead of the usual two. These groups are typically identical, not only in the number, but also in the nature of their members; thus being homologous groups. On the other hand (*b*), in certain genera, species, or subspecies, have been found the haploid number of chromosomes of which is two, three, or four, etc., times that of the half number of a basic species in the same genus. In typical cases of this kind these extra chromosomes are not homologous, or not completely homologous, with those of the basic group.

Now in the first case (*a*), the words diploid, triploid, and tetraploid have been some time in use. It would be scarcely possible, in the writer's opinion, to change the application of the word 'diploid,' for example, and confine its use to case *b*, as has been lately suggested (O. F. I. Langlet, *Svensk Bot. Tidskr.*, vol. 21, pp. 1-17; 1927). The cytologists who are doing such praiseworthy work in counting the chromosomes in different genera are not compelled to make use of a Greek terminology already employed in a different sense. They may have recourse to the mother tongue, and the terms, ***single, double, triple, quadruple . . . multiple***, convey no necessary implication of homology, and would hence suit case *b*. Or, if technical terms are wanted, they are at hand in the Latin, where ***uniplex, duplex, triplex, quadruplex . . . multiplex***, await application to case *b*.

JOHN BELLING.

Carnegie Institution of Washington,
Department of Genetics,
Gold Spring Harbor, Long Island, N.Y.,
May 27.

Absorption Bands of Liquid and Vapour Amines.

BY measuring, below wave-length 4 μ, the absorption of secondary and tertiary solid and liquid amines, it was shown that the N-H bond has a strong characteristic absorption band around 3 μ (*Proc. U.S. Nat. Acad. Sci.*, **12**, 74; 1926). It seemed, from the data on various substances by other workers, that this was an overtone of a fundamental at 6 μ.

Measurements, with a rock-salt prism spectrometer, of the absorption of longer waves by liquid and vapour amines, have recently been made here. They show a weak 6 μ band both for secondary and tertiary amines, so that this band cannot be taken as the fundamental of the 3 μ N-H, the latter being, then, a fundamental.

This is in harmony with the recent results of Ellis for aniline liquids, whose very accurate measurements below 2·8 μ showed a series of overtones characteristic of N-H, the calculated fundamental of the series extrapolating to 2·8 μ, not to 6 μ (*J. Am. Chem. Soc.*, **49**, 347; 1927).

E. O. SALANT.

Physics Department, Johns Hopkins University,
Baltimore, Maryland, U.S.A.,
May 19.

Unauthorised Publication of the "Grammar of Science."

MESSRS. STECHERT AND CO., of New York, have issued, entirely without my sanction, a reprint of the last edition of my "Grammar of Science." Copies of the book have been recently sold in England. I should like to inform possible purchasers, through the columns of NATURE, that the book is unauthorised and can only be sold illegally in Great Britain.

Messrs. Stechert & Co. kindly inform me, having regard to the issue of a new and revised edition, that "it is better"—they do not say for whom—"to have the book constantly on the market." It is needless to add that the "Grammar of Science" in its last edition, without a thorough revision, is not a book such as I should wish to issue under my name; it is not abreast of the recent advances in physical science and epistemology.

This is not the place to comment on the morality of American copyright law.

KARL PEARSON.

University College,
London, W.C.1.

Some Recent Services of Metallurgy to Engineering.[1]

By Prof. H. C. H. CARPENTER, F.R.S.

IN honouring me with the invitation to deliver the James Forrest lecture this year—the thirty-third of the series—the Council of this Institution expressed a desire that I should deal with recent advances in metallurgy which have a bearing on engineering practice. It is twenty-one years since my distinguished predecessor Sir Robert Hadfield delivered the last lecture in which metallurgy constituted the main subject, and it would seem convenient, therefore, that I should deal with the progress made since that date.

FLOTATION.

As regards ore-treatment, water-concentration is eminently satisfactory in the concentration of ore containing relatively coarse and granular mineral and a light gangue. Chemical treatment is equally satisfactory when the valuable mineral crushes to powder and the gangue is not soluble. Between these two lies the field of flotation, this method of concentration being effective both in the presence of a heavy gangue and a fine mineral. It belongs to the present era of mining, which dates back to the exploitation of the rich auriferous gravels of California and Australia about the middle of the nineteenth century, though the first flotation process to be applied commercially was that developed by Elmore in London in 1898. He was, moreover, the first to apply the selective action of oil to a pulp flowing freely from a wet-crushing machine. Put briefly, in flotation the mineral is floated on an air froth, while the gangue sinks to the bottom, whereas in concentration the mineral sinks to the bottom and the gangue is floated away.

There are three main types of froth-flotation machines, known respectively as the mechanical, pneumatic, and cascade. Of these the mechanical flotation machine is the widest applied. The standard pattern machine has a capacity of about 1·25 tons per square foot of machine area per day. A machine of ordinary size will treat about 400 tons per day, and require about 100 H.P.

Flotation first established itself by the recovery of lead and zinc-blende from an association with heavy gangue at Broken Hill, New South Wales, its success being complete about 1910. Whereas with water concentration, before the advent of flotation, the recovery was only 60 per cent. of lead, less of silver, and none of the zinc, the recoveries to-day are about 85 per cent. of the lead, 65 per cent. of the silver, and 83 per cent. of the zinc. These percentages do not include the lead in the zinc concentrate, or the zinc in the lead concentrate. The cost of flotation is about 6*s*. per ton, and that of complete dressing about 9*s*. per ton. At the Butte, Superior, Montana, the present recovery is about 92 per cent. from an ore assaying about 17 per cent. of zinc, flotation being responsible for about three-quarters of the production.

At Anaconda, where in 1915 the recovery of copper by water was 78 per cent., a flotation equipment was erected in the expectancy of raising the recovery to more than 90 per cent. This expectation has been realised. At Utah-Leasing, Newhouse, Utah, a tailing dump containing about 700,000 tons, assaying about 0·7 per cent. of copper, was successfully treated by flotation, the concentrate assaying about 18 per cent., and the final tailing about 0·2 per cent. At Calumet and Hecla at Lake Superior, a conglomerate of ore containing native copper is treated by a flotation plant having a capacity of about 2000 tons per day. From this material, which contains less than 1 per cent. of copper, a recovery of 60 per cent. is made at a cost of about 10*d*. per ton.

To-day, in fact, flotation is applied on practically every important non-ferrous mining field. Tin alone has not yet benefited by it. In general terms, where formerly water concentration yielded a 65 per cent. to 70 per cent. recovery, the adoption of flotation has raised the recovery to from 80 to 85 per cent.

REVERBERATORY FURNACE SMELTING.

As the finely divided concentrate cannot be smelted in a blast furnace, one of the principal consequences of the development of the flotation process has been the necessity of designing a new type of furnace. This has been developed from the original small reverberatory furnace, used many years ago in copper smelting in Swansea. The modern furnace, however, is so much larger and its method of working so different that the process is really a new one.[2] The fuel used in the modern large reverberatory furnace is pulverised coal or fuel-oil, depending upon the relative cheapness of the two fuels. When pulverised coal is used, it is ground so that 80 to 90 per cent. will pass a 200-mesh screen, and is blown into the furnace with about 15-oz. air pressure. The coal used may vary in ash content from 6 to 7 per cent. up to as high as from 15 to 20 per cent., without giving trouble. The ratio of charge to fuel varies from 5 to 7½ : 1. The burners are inserted directly in the rear wall of the furnace, and several are used, from four to six being the usual number. The type of burner varies in each plant with apparently equally satisfactory results.

When using fuel-oil in the furnaces it is generally from 17 to 19 Bé., and is preheated to about 200° F to 250° F. before burning, as this results in fuel economy. When as much heat as possible has been extracted from the gases, they are passed through waste-heat boilers for a further recovery. These are from 500 B.H.P. to 750 B.H.P., and are frequently connected to a common cross flue, extending from all the reverberatory furnaces, so that in case of a shutdown of a furnace the boiler capacity will not be lost; and if a boiler is down for cleaning or repair, the other boilers are available for the utilisation of the waste heat. It has been found advisable to have the flues from the furnaces to the boilers sloping slightly towards the furnaces, as otherwise trouble may be experienced from the accumulation of slag.

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[1] From the thirty-third James Forrest Lecture delivered before the Institution of Civil Engineers on May 3.

[2] Liddell, "Handbook of Non-Ferrous Metallurgy," vol. 2, pp. 948-951.

The reverberatory furnace is the most satisfactory apparatus in which to treat fine ores, but it usually requires an extensive roasting plant, occupies a large amount of space, and locks up a large amount of valuable metal. Hence the investment is large for a given tonnage.

Leaching.

Copper has been extracted from its ores by heap-leaching methods in Spain since 1752, but these contain from 2 to 3 per cent. of metal. With modern methods it is economically possible to treat ores containing much smaller quantities of copper. In the spring of 1923 the Ohio Copper Company of Utah commenced the leaching of an ore which averages only 0·3 per cent. of copper. This has since proved to be a profitable undertaking. It consists of a copper-bearing quartzite, in which the copper minerals exist principally in the fissures. The quartzite is practically inert to chemical action, while the copper minerals are readily attacked by the leaching solution. At the Calumet and Hecla mine, an old tailing containing only 6 lb. of copper per ton (0·27 per cent.) has been successfully treated by an ammonia process. It has been estimated that about 15 per cent. of the copper output of the world is now produced by leaching, and two of the largest of such plants in operation at the present time produce copper at a considerably lower cost than by any other method of treatment. The leaching of copper and silver ores is now in a similar position to that of gold and silver cyanidation, and, especially in the case of copper ores, the process and plant used have followed very closely those employed for cyanide work. Since 1905, processes for the wet extraction of zinc and lead have been developed, and will probably in a few years become formidable rivals to smelting methods. Already the wet metallurgy of zinc is of considerable economic importance. Lead leaching at the moment has not attained so favourable a position as copper and zinc, and there is room for much further research in this direction.

Refining.

Twenty years ago the manufacture of steel in the electric furnace was still in the embryonic stage. To-day more than 1200 such furnaces are in operation in Europe and America (including Canada), in about equal numbers in the two continents. In the decade 1910–20 the development of what may be called 'electric steel' has been astonishing. It increased from 52,141 tons in 1910 to 502,152 tons in 1920. In 1925, 1,042,000 tons were produced, of which the U.S.A. was responsible for 615,000, Italy 129,000, Germany 127,000, France 68,000, and Great Britain 44,000. The principal use of such furnaces has been in producing alloy and tool-steel ingots and castings. The first advantage of the electric furnace is its flexibility; the second consists in the method of applying the heat; and the third lies in the quality of the product. The outstanding disadvantage of the electric process is its cost. It may be expected that, with the continued improvement in efficiency of power-production plants, this disadvantage will tend to become less and less. Another factor which will operate in the same direction will be that economies in furnace operation will be more thoroughly understood and practised. Another disadvantage, from which the furnace has suffered more or less hitherto, is that it has been operated by men unfamiliar with its possibilities. To some extent the view has prevailed that electric steel occupies a field midway between acid and basic open-hearth steel and crucible steel. This is not the case. The quality of electric steel is fully equal to that of crucible steel, and can be achieved provided that refining is properly carried out metallurgically. If the electric steel is manufactured with care and the metallurgical treatment is correct, none of the five classes of non-metallic impurities (of which products from the reaction between dissolved and suspended oxides and gas and deoxidisers, and oxides not acted upon by deoxidisers, are the most important) ought to be present in more than small amounts. Except for small amounts of manganese sulphide and silicate, electric steel should, in fact, be free from non-metallic inclusions when melted with restricted or with no oxidation. Even when melted with complete oxidation, if it is deoxidised thoroughly it should still be cleaner than basic open-hearth steel.

Oberhoffer and Beutell[3] have shown that in a very large number of open-hearth steels the gas dissolved averaged from 13-130 c.c. per 100 grams of metal. The gas contained about 75 per cent. carbon monoxide, the rest being hydrogen, nitrogen, and a small amount of carbon dioxide. Steel metallurgists have paid far too little attention to the presence of gas in steel and to the effect on its quality, but it has been proved that the content nitrogen reduces the tensile strength, and still more the ductility. In the open-hearth process the atmosphere with which the metal is in contact contains oxygen, nitrogen, hydrogen, and carbon monoxide. In the electric process, on the other hand, the amounts of oxygen, hydrogen, and nitrogen should be very much less, and the only gas that should be present in any quantity is carbon monoxide. Even this will only occur in small amounts, as furnace gases containing oxygen are absent. Precise figures as to the amounts of gas actually present in electrically-made steel are, however, still lacking.

'Pearlite' Cast Iron.

One of the outstanding advances of the last twenty years has been the practical use of the equilibrium diagram in the scientific manufacture of industrial metals and alloys. So important has this aspect of metallurgy become that in 1920 a society was founded in the U.S.A. known as the American Society for Steel Treating, for the purpose of improving the scientific manufacture of metals. This society has to-day a membership of 3500.

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[3] *Stahl und Eisen*, 1910, vol. 30, pp. 1584-90.

High-carbon iron carbon alloys solidify 'white' unless a particular stimulus is present to cause the precipitation of graphite. They consist accordingly of cementite and pearlite. Since 'white' iron is so hard as to render it incapable of being machined, its use is greatly restricted in mechanical engineering work. The addition of silicon, however, causes the formation of free carbon from such a white iron, and it is possible in certain favourable conditions, including slow cooling, to produce a cast iron consisting only of silico-ferrite and foliated coarse graphite. Such a material is very weak, although soft, and apart from a few special cases, such iron is but little used for mechanical engineering work. Between these two limiting conditions come the usual technical kinds of grey iron. The microstructure depends on the smelting and casting processes used, the conditions of solidification and cooling after casting, and upon the chemical composition. The rate of cooling is, of course, considerably affected by the cross-sectional area of the particular casting. In the microstructure of ordinary grey iron are usually found together varying quantities of graphite, silico-ferrite, pearlite, free cementite, and the phosphide eutectic, with inclusions of iron and/or manganese sulphide.

A carbon steel containing 0·9 per cent. of carbon consists, when annealed, of eutectoid pearlite only, the structure being uniform and dense. This material is pure steel. It has, as is well known, very remarkable mechanical properties. The problem of improving the qualities of cast-iron consists essentially in preparing a material composed mainly of pearlite with deposited graphite. A cast iron of this kind would certainly be superior in properties to any of the ordinary varieties, and it might be expected to exhibit mechanical properties approximating to those of pearlite steel, which would be influenced only by the graphite. Numerous tests carried out by different investigators on castings approximating to the above structure bear out this view. It was at first not found possible to get the desired structure in current practice. Diefenthaler and Sipp were, however, able to devise a process to enable this structure to be obtained regularly. It was patented in 1916. It has been improved upon, and has finally led to very definite rules for achieving the desired properties.

The properties found in the cast iron are: (1) High transverse and tensile strengths and toughness; (2) high resistance to impact stresses; (3) moderate hardness when properly treated; (4) only a slight tendency to the formation of 'pipes' and hence the possibility of making complicated castings; (5) great resistance to sliding friction (abrasion); and (6) fine and dense structure which is unaffected by temperature changes.

SORBITIC STEEL.

Steel wire ropes, after passing through the 'patenting process,' which consists in heating to a temperature at which steel scales, and then cooling more or less rapidly through the critical points, contain large quantities of 'sorbite' readily detected by the microscope after etching, or by the dark colour that the whole surface assumes when etched side by side with the rod before patenting. The property of enabling the patented rod to be drawn to a much greater fineness than is possible in the unpatented material is due to the effect of the sorbite present. Stead and Richards[4] concluded that if sorbite is responsible for the excellent qualities of oil-quenched steel and negatively quenched steel wire rods, there is no reason why it should not be produced in steel rails, tires, etc., without great expense. With this object in view they experimented on 5-foot lengths, subjecting them to a variety of treatment.

Although the results of these experiments were decidedly promising, they were not able satisfactorily to treat a normal 30-foot length of rail. In all cases the distortion of the longer lengths was so considerable that their process never became a commercial success. The practical problem of treating the full lengths satisfactorily has been solved by Messrs. Sandberg so as to produce sorbitic structure. They realised that the right temper in the rail could be obtained in the course of one single operation if the correct rate of cooling through the critical range of temperature was secured. The precise range depends upon the composition of the steel. Their experiments using air-cooling were so encouraging that they were soon able to treat full-length rails of heavy section. The results obtained made it perfectly clear that their process could be carried out without interfering in any way with the output of the rail mills and at a comparatively low expenditure. The first rails treated were tramway rails, and gaugings taken from these after they had been one year in the track under very severe traffic showed that their life would be about 100 per cent. longer than that of the Sandberg high silicon rails of the same composition but untreated and laid at the same time in the same track. Plants for the Sandberg treatment of rails were put down by the Bethlehem Steel Company at their Sparrow Point Works, where trials were carried out and excellent results obtained. Shortly afterwards another plant was put down at the Dowlais Works of Messrs. Guest, Keen and Nettlefold, while a number of trial orders have been carried out on rails for various home railways.

The tensile strength of rails has frequently been raised from about 55 tons per square inch untreated to 65 and 70 tons per square inch after treatment, and even higher, without showing any signs of brittleness. Treated rails have, in fact, stood up to twice and even three times their specified falling weight test without breaking. The Brinell tests also clearly show that the process does not merely give a surface hardening, but that the treatment effect is produced throughout the head. The increased resistance to shock is due to the peculiar fineness of the structure of sorbite, which also gives smaller surface particles for tearing away by abrasion, and thus greatly reduces the wear in service. From careful observation under severe traffic conditions it has been found that treated rails have given double the life of untreated rails, and in some cases even better results have been obtained.

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[4] *Journal of the Iron and Steel Institute*, 1903.

HIGH-SPEED TOOL STEELS.[5]

The revolutionary feature wherein tools made of these steels differ and exceed in service the tools formerly used, is their ability to maintain a sharp, strong cutting edge while heated to a temperature far above that which would at once destroy the cutting ability of a simple steel tool. A high-speed tool can be made to cut continuously at speeds from three to five times as great as that practicable with other tools and even when, as the result of the friction of the chip on the tool, it may be red hot at the point on top where the chip rubs hardest, and the chip itself may, by its friction on the tool and the internal work done on it by upsetting it, be heated to a blue heat of about 300° C. or even hotter. Accordingly these tools have in the past twenty years worked a remarkable revolution in the machine-shop business of the whole world, affording largely increased outputs and commensurately lower costs. As a consequence they are now used very generally, and in some shops almost exclusively, for machining iron and steel as well as some other metals by cutting operations by machine tools.

The property of red hardness, or ability to retain hardness at a red heat, may be imparted to steels of suitable composition containing chromium, tungsten and vanadium and, in the most recent tools, cobalt as well, by a unique heat treatment to which they are subjected. This is the Taylor-White process[6] introduced at the works of the Bethlehem Steel Company in 1899. Tools thus treated were shown at the Paris Exhibition in 1900.

In the early days, after a good deal of experiment, the composition settled down to a basic one of about 14 per cent. of tungsten with from 3 to 4 per cent. of chromium. The next step was to introduce still greater percentages of tungsten and also to add vanadium. A class of steel has now been on the market for some time containing about 18 per cent. of tungsten, 4 per cent. of chromium, and anything up to 2 per cent. of vanadium. This class appears to have justified itself as indicated by the wide demand for it. The latest development came comparatively recently with the addition of cobalt (from 2 to 6 per cent.). These steels have also taken their place and found a market. In some steels molybdenum is added as well as the above four alloy elements.

The cutting edge of a rapid tool at work is probably never so hot as the metal which is behind it, where the heating caused by the friction of the chip as it is deflected and rubs hard on the tool is most intense. The edge itself is kept relatively cool by the cold metal flowing upon it. It is not generally realised that the point of the tool does not cut, and that it only drives open the crack which advances in front of it. A high-speed tool fails through the turning, which impinges on the top face of the tool, wearing away the steel until the cutting edge is actually broken off.

MUMETAL.[7]

The first commercial application of high-frequency melting in Europe was made by a British firm for the preparation of nickel-iron alloys for submarine cables. The research work pursued in order to find a suitable alloy was thereby much facilitated, and quickly resulted in the perfection of the series of alloys known under the name of 'mumetal' (so called because the Greek letter μ is used as the symbol of permeability). These alloys have highly desirable characteristics, and by their use the speed of cabling can be increased seven to eightfold.

A typical mumetal alloy has the following composition:

Nickel	74·0 per cent.
Iron	20·0 ,,
Copper	5·3 ,,
Manganese	0·7 ,,

An alloy of this composition has a magnetic permeability of 7000. Low hysteresis loss with a very high permeability at low magnetising forces are the characteristics chiefly required in these metals.

The composition of the mumetal may be varied according to the type of cable which it is proposed to use, and the annealing may be adjusted to give either (*a*) maximum neutral permeability, (*b*) maximum permeability at magnetic saturation, or (*c*) high or low fields for magnetic saturation.

The range of alloys developed for this class of work contains from 75 per cent. to about 50 per cent. of nickel, with percentages of iron varying from 20 to 25, and certain quantities of copper and manganese, but in every case freedom from carbon is one of the primary essentials, and for this reason the high-frequency furnace has proved the only suitable melting equipment.

In certain types of cable an increase in electrical resistance of the alloys is desirable, and in this case an extra element, which may be tungsten, chromium, silicon, vanadium, titanium, molybdenum, or aluminium, may be added in small quantities.

ANTI-CORROSION METHODS.

Aluminium is ordinarily covered with a protective film of oxide or hydroxide. It does not, however, constitute a perfect protection in the presence of corrosive liquids and even neutral salt solutions. It tends to crack and lose its power of adhesion to the metallic surface. Local corrosion (pitting) then sets in. Moreover, this film is much more liable to crack when subjected to alternate wetting and drying, particularly at an air-liquid interface. Probably the interfacial tensions of metal, air, and water operate in producing this result. The practical problem therefore consists in finding a method of forming a strong and tightly adherent film of oxide or hydroxide instead of the thin film. Mott[8] showed that such a hydroxide film could be formed by making the metal the anode in a bath of sodium hydrogen phosphate, and recommended this treatment as a protection against corrosion. Working for the Corrosion Research Committee of the Institute of Metals, and with the aid of financial assistance from the Department of Scientific and Industrial Research, Dr. Bengough and Mr. J. M. Stuart, during the years 1921–24, carried out a series of investigations starting from this point, and found that the film produced by 'anodic oxidation' in a bath containing a chromate, bichromate or, best of all, chromic acid, protects the metal much more effectively against corrosion.

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[5] Hibbard, "Manufacture and Uses of Alloy Steels."

[6] Taylor, F. W., "On the Art of Cutting Tools," *Trans. Am. Soc. Mech. Eng.*, vol 28 (1908), pp. 31-350.

[7] Campbell, *Journal of the Iron and Steel Institute*, vol. 112, p 74

The process is carried out as follows: "After thoroughly cleaning the surface of the aluminium or its alloy, it is immersed in a suitable bath, *e.g.* dilute chromic acid, along with a carbon rod; a small external electromotive force is applied so as to make the aluminium the anode and the carbon the cathode. The applied electromotive force is gradually raised to a value depending on the nature of the alloy and on the composition of the bath. Thus with duralumin in a chromic bath the voltage may be safely raised to 50 volts. After treating for some time in this manner, the surface of the metal becomes covered with a semi-opaque uniform white coating. This seems to consist almost entirely of aluminium hydroxide in a glassy adherent form. The hydroxide is possibly hydrated to some extent, but the hydration cannot be much, since the coating can be heated to at least 350° C. without changing in appearance or density."

The laboratory investigations were followed by successful experiments on a larger scale at the Royal Aircraft Establishment at Farnborough, by agreement with the Air Ministry, and the process, which is protected by patent, is now being worked in Great Britain by several firms on non-exclusive licences from the Department of Scientific and Industrial Research.

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[8] Mott, "Electrochemical Industry," 1904, 2, p. 129.

Organography of Plants.[1]

A 'FESTSCHRIFT' celebrating the seventieth birthday of Dr. Karl von Goebel, professor of botany in the University of Munich, was published in 1925 as a special volume of *Flora*. It was initiated by an international committee including many of his colleagues, pupils, and friends: it comprises thirty-eight memoirs on the most varied botanical topics, and these themselves bear witness to the catholicity of the interests of the veteran whose birthday they celebrate. His election in 1926 as a foreign member of the Royal Society has marked the recognition in Great Britain of his great scientific career, happily by no means ended, though it has reached the prescribed span of life. These events followed closely upon the completion of the second and greatly enlarged edition of his "Organographie der Pflanzen" The interest which they have aroused among botanists is readily understood, for the name of von Goebel is intimately associated with an essential change of scientific outlook upon the organisation of plants. This has lately been made more than ever apparent in a volume from his own pen, written in celebration of the centenary of the birth of his teacher, Hofmeister, a translation of which into English was lately published by the Ray Society, and reviewed in NATURE (Oct. 2, 1926, p. 473). This essay reveals with a truly philosophic touch the genius of the master, while it serves also as a natural guide to any appreciation of the life-work of the pupil, von Goebel himself.

In the early part of the nineteenth century a stiff and artificial nature-philosophy was still dominant. This was clearly incompatible with those evolutionary views which were then forming themselves in men's minds. Even before "The Origin of Species" was published, a change of outlook had been initiated. Hofmeister's keen insight had tracked down, and his pencil had recorded in detail, facts relating to Archegoniate plants, which more than any others were at that time essential for any consecutive evolutionary scheme for the plant kingdom as a whole. These facts were stated by Hofmeister with a breadth of view which allowed of their ready application later in terms of adaptation to environment. He was not merely an observer of stark structure, but he broached the subject of causal morphology, a branch of study then only nascent, but great with the promise of the future.

It has been the happy lot of von Goebel as his pupil to carry on the torch which Hofmeister had thus placed in his hands, and to deliver it with ever-increasing glow to a later generation. Morphology in his hands has taken a more rational place than was possible before. Under the title of "Organography,"—a word already used by Sachs in 1882, from whom also von Goebel will have drawn stimulus and guidance in the years of his assistantship in Würzburg—he has embodied in two stately volumes a wealth of fact treated comparatively, experimentally and developmentally, and related throughout to function. While maintaining the Hofmeisterian tradition of exactitude, he has promoted the living aspect already so prominent a feature in Hofmeister's later writings. The first edition of von Goebel's great work was translated into English, and published as one of the botanical series issued by the Oxford Press (1900–1905). The second German edition, completed in 1923, may be held as embodying the mature views of its author: at the same time it reflects the attitude of modern morphology, in which form is not divorced from the study of function as it used to be.

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[1] 1 "Organographie der Pflanzen," Dr. K. Goebel. Zweite Auflage. (Jena: Fischer, 1913–1923.)

2 "Die Entfaltungsbewegungen der Pflanzen" Ergänzungsband zur Organographie der Pflanzen (Jena: Fischer, 1924.)

3 "Festschrift zum siebzigsten Geburtstage von Karl von Goebel, in Munchen" (Jena: Fischer, 1925.)

4. "Morphologische und biologische Studien" Von Prof. Dr. K. von Goebel *Ann. Jard. Bot. de Buitenzorg*, 36. (Leyden, 1926.)

The closing volume, styled "Ergänzungsband zur Organographie der Pflanzen," was published in 1924: it relates to the movements of development of plants, and their teleological meaning. While the author at once notes that erroneous teleological interpretations have frequently been enunciated in the past, and points out how movements may exist to which no useful end can be ascribed, he boldly accepts legitimate teleological interpretations. He asserts that organography is in itself the discussion of the relations that exist between morphology and teleology, and he quotes from Asa Gray the passage: "Let us recognise Darwin's great service to natural science in bringing back to it Teleology: so that instead of Morphology versus Teleology we shall have Morphology wedded to Teleology." The broad sweep of this volume, the variety of the facts adduced, and the wide quotations of literature, often varied in origin and remote in time, impress the mind with the catholicity of interest of its author. It fully justifies an incident that occurred long ago at an international meeting of botanists, where an unusual plant presented a puzzle to us all, and some one said, "Ask Goebel." The question was not put to him in vain.

To British students of botany the name of Goebel will have first become familiar through the publication of a translation of his "Systematik" under the title "Outlines of Classification and Special Morphology of Plants" (Oxford Press, 1887). It was in fact a new edition of Book II. of Sachs' text-book. But, earlier still, the young professor of Rostock had profoundly impressed those of us who followed the German botanical literature by his writings in the *Botanische Zeitung*, and elsewhere. Much of this early work was summed up in his "Vergleichende Entwickelungsgeschichte der Pflanzenorgane," included in Schenck's "Handbuch der Botanik" (vol. 3, 1884). Here, with the true Hofmeisterian touch, he uses ontogenetic details as an avenue to comparative conclusions. In his hands the story of floral development, traced in skilfully selected examples, furnished a living commentary upon the dryer facts of Eichler, and rendered them into terms more closely related to the life of the organism. On the other hand, his comparative studies of the development of the sporangium might at first sight appear as mere *tours de force* of developmental observation. But they worked out naturally into questions of the widest evolutionary interest. In the 'eighties we soon found ourselves reaching out towards some ultimate point of view as to the real nature of the sporangium of land-living plants: whether it is a part *sui generis*, or the result of some transformation of a pre-existent part, as the older morphologists had held. Or we entered deeply into the cell-cleavages which precede the definition of the sporogenous cells, in a study which lent precision to knowledge of development, but left us there in a manner stranded. In either case we were brought face to face with far-reaching questions of ancestry and origin, which even the subsequent disclosure of the fossils of the Rhynie Chert have not fully resolved.

As an administrator von Goebel has taken his full share of duty. The head of a large institute and garden, he has passed through his hands a stream of pupils drawn from many nations. Since 1889 he has edited *Flora*; and the pages of that great journal not only witness to his own activity, but also show the variety and quality of the work of his school. But it would be vain to attempt here to follow this indefatigable worker through all the activities of a long and busy life. The mere list of his publications as given in the 'Festschrift' runs to nearly two hundred titles, many of them books. It is more to the point here to refer to one of his latest works, published since his seventieth birthday. Travelling recently to Java, as he wrote in a private letter "once more to see the tropics," he did not go as a mere spectator, but as a worker. A volume of two hundred pages with sixteen plates, entitled "Morphologische und biologische Studien," is the result. In it he canvasses questions ranging from the lichens to the flowering plants. Specially characteristic is the memoir on the relations of certain Javanese ferns; for here von Goebel selects some which are well known as presenting systematic problems, and helps materially towards their solution. It is inevitable in such work that differences of opinion should arise. But here there need be no apprehension; for when von Goebel differs, he lays all his cards upon the table, and after expressing his own opinion he will adorn the difference with a quotation from the classics, or it may be with a humorous touch which leaves the social field unscathed, while the scientific arena is as open as before for friendly rejoinder.

It will be gathered by those who know von Goebel only by name that we see in him a very impressive figure: the bearer of a great tradition from the past, who through a long life has amplified and extended it. More than any other writer of the time he has saved plant-morphology from itself, by diverting its higher pursuit from formal and scholastic channels, and leading its adherents by preference towards middle lines of thought. This tends to promote the general advance much more effectively than any narrow specialism. Unfortunately the mental effort involved in the pursuit of some circumscribed theme is much less than that entailed by more generalised study. It is this that is apt to exercise an undue influence on those who desire to achieve immediate results, an attraction always resisted by von Goebel.

F. O. B.

Obituary.

Dr. E. S. Hartland.

Dr. Edwin Sidney Hartland, the elder son of the Rev. E. J. Hartland, Congregational minister, was born at Islington in 1848. He joined the legal profession when a youth and practised as a solicitor at Swansea from 1871 to 1890. He was the first Clerk to the Swansea School Board and throughout his life devoted much of his time to further Welsh education, being much interested in educational matters in Wales and also in Public Libraries. In 1890 he was appointed Registrar of the County Court at Gloucester, and District Registrar of the High Court, and afterwards was appointed District Probate Registrar. Here he continued to act as a public-spirited citizen and gave especial attention to education. He was an alderman and mayor of Gloucester, chairman of the City Education Committee, of the Board of Governors of the secondary schools, and of the Public Library and Museum Committee. In the spring of 1924 a grave illness compelled him to resign all his public duties, and thereafter he was debarred from all physical and mental exertion. During the years he was bedridden he was always unrepining and cheerful and retained his sense of humour. The end came peacefully on June 19. He is survived by his widow, one son, and two daughters.

In recognition of Hartland's contribution to the study of folklore the degree of LL.D. was conferred on him by the University of St. Andrews in 1917, and that of Lit.D. by the University of Wales at Bangor in 1924. He presided over the Anthropological Section of the British Association at York in 1906, and over the Section of the Religions of the Lower Cultures of the International Congress of the History of Religions held at Oxford in 1908. He delivered the first Frazer Lecture at Oxford in 1922, and was awarded the Huxley medal by the Royal Anthropological Institute in 1923, but was prevented by ill-health from delivering the Huxley Lecture.

When one remembers the busy life Hartland spent in public duties it is surprising what an amount of literary work he accomplished. He was an early member of the Folk-Lore Society, and for many years was a contributor of articles and reviews to the journal of the Society, also as member of the council and as president of that Society, and, in continually helping other students by his erudition, he did a very great deal to establish folklore as a serious study. Folklore for Hartland was not merely the collection of curious superstitions and odd usages and rites, but he sought for their interpretation by an extensive and intensive study of anthropological literature, as is well exemplified in his great work, "The Legend of Perseus" (1894–96), and in "Primitive Paternity" (1909–10) and "Ritual and Belief" (1914). In addition to many papers in folklore, anthropological, and archæological journals published in Britain and elsewhere, Hartland wrote some important articles for the "Encyclopædia of Religion and Ethics," and in various other ways he did what he could to spread an interest in the anthropological aspect of the survivals of belief and custom found among civilised peoples. He was interested in the problems connected with matrilineal and patrilineal kinship, and in the relations of magic and religion.

It will be evident that Hartland studied a wide range of subjects, to all of which he brought to bear a mind trained in the value of evidence and a sympathetic, kindly nature. His writings are marked by a pleasing, lucid style with occasional lighter touches. He was a typical representative of the British school of anthropologists of the latter part of the nineteenth century. He often took an independent line and regarded "criticism as a form of co-operation in the pursuit of truth," but in criticism and debate was always tolerant and friendly. His place in the history of anthropology is assured. Few of his contemporaries now remain, but to them he will be remembered as a genial and constant friend who was always ready to receive and impart information. A complete list of his writings will be published in an early issue of *Folk-Lore*.

A. C. Haddon.

Dr. Irving Bardshar Crandall, a member of the technical staff of the Bell Telephone Laboratories and an authority on the telephonic transmission of speech and methods of recording it, died on April 22, at the age of thirty-six years. Dr. Crandall was born in Chattanooga, Tenn., on May 27, 1890, and graduated from the University of Wisconsin in 1909; later he studied at Princeton, and in 1916, three years after he had become associated with the Bell Telephone Laboratories, he received his doctorate from Princeton. At the time of his death, Dr. Crandall was engaged on important experiments. He recently published a book, "Sound and Vibrating Systems," and he had previously written monographs on the scientific aspects of speech, analyses of its mechanisms, and methods for recording it.

We regret to announce the following deaths:

Prof. Gustave André, professor of agricultural chemistry at the Institut National Agronomique, Paris, who contributed to our knowledge of plant absorption and assimilation of elements from the soil, on May 14, aged seventy years.

Surgeon-General Henry Cook, I.M.S. (retd.), formerly principal and professor of medicine and hygiene at Grant Medical College, Bombay, and dean of the Faculty of Medicine in the University of Bombay, on May 30, aged ninety-five years.

Father William F. Rigge, for many years director of the observatory of Creighton University, Omaha, who was known for his work on eclipses and eclipse maps, on Mar. 31, aged sixty-nine years.

Dr. G. von Tschermak, emeritus professor of mineralogy and petrography in the University of Vienna, aged ninety-one years.

Dr. Anton Wassmuth, formerly professor of mathematical physics in the University of Graz, aged eighty-two years.

News and Views.

A case of considerable interest to owners of land, to entomologists, and to public health authorities, has recently been heard in the Sheriff Court of Paisley. The pursuers, the Committee of the Upper District of the County of Renfrew, craved the Court to find that there exists upon the lands of Muirend, in the Parish of Cathcart, a nuisance within the meaning of the Public Health (Scotland) Act, 1897, in that certain ditches are so overgrown with vegetation that the flow of water therein is impeded and they have become breeding-places for mosquitoes. Complaints were received from a considerable number of residents in the houses within about five hundred yards of the Muirend estate that they had suffered severely as the results of mosquito bites, medical treatment having been rendered necessary in a number of cases. The pursuers therefore held that the ditches are "in such a state as to be a nuisance, or injurious or dangerous to health," and they craved that the defender (the owner of the land) should be required to clean out the ditches and to do such other things as may be required for the removal of the nuisance complained of. The mosquito in question is *Anopheles bifurcatus*.

The defender's reply to the petition is that the existence of mosquitoes does not constitute a nuisance in the sense of the Public Health Act, and also that the bed of the stream a short distance beyond his property has been raised, thus causing damming back of the water. The inquiry lasted four days, and expert witnesses were heard on various aspects of the problem—engineering, entomological, medical, and legal. Sheriff Hamilton has decided in favour of the District Committee. He finds that the ditches have become so encumbered with silt and vegetation as to be ineffective as watercourses; that the ditches and the adjacent overflowed ground have become a breeding-ground for large quantities of mosquitoes; that mosquitoes from the area in question have invaded the residential district and attacked the inhabitants, and by their bites caused pain and swelling, occasioning in some cases temporary incapacity; that the presence of mosquitoes caused reasonable apprehension and diminution of comfort in the community; and that there is a reasonable probability of a repetition of these conditions in the following years. The Sheriff ordains the defender to clear the ditches of the silt and vegetation with which they are encumbered, and thereafter to maintain them clear of silt and vegetable growth. The case is of special interest as being the first of its kind under the Public Health Acts in Great Britain.

The opening by Lord Onslow of the new Reptile House at the Zoological Gardens in Regent's Park, London, on June 15, marks an important stage in the development of the exhibition of living animals. The extraordinary appeal which the overhead lighting of the Aquarium made to the eye of the public ensured that this method would be extended to other types of exhibits, and a first experiment in this direction was made at the Scottish Zoological Park, where, a little more than a year ago, there were opened to the public a tropical bird house and a reptile house with natural surroundings, in which daylight falls upon the inmates while the spectator is shielded from the direct rays. The new Reptile House at the London Zoo develops still further the ideas of concentrating attention upon the animals and of suggesting in the enclosures themselves the type of surroundings in which the various creatures naturally dwell. The technical experiments and artistic conceptions of the curator, Miss Joan Procter, have combined to give most successful results. In the larger enclosures the natural surroundings of the foreground are very effectively carried away into the distance by suitably designed backgrounds painted, for endurance, with motor-car enamels; vita-glass permits the access of the most beneficial of the sun's rays; and the compartments are fitted with elaborate electric installations for heating and lighting. Many of the creatures exhibited are themselves of the greatest interest: the seven-foot, yet immature, 'dragons' of Kermodo are shown alive for the first time in Europe; but the scheme of the Reptile House adds enormously to the attractiveness and to the instructional value of the exhibits. The new house bids fair to catch the public fancy as completely as the Aquarium has done.

The Royal Society of Edinburgh, like many another learned society, is concerned at the increasing volume of material offered for publication, and at the inroads which the publication of work of first-rate quality is making upon its resources. Its *Transactions* and *Proceedings* are very largely financed by the contributions of its fellows, with modest assistance from a Government grant and occasional help from the Government fund allocated by the Royal Society of London. Already the fellows have contributed a special Reserve Fund of £1100, but it is evident that if further provision cannot be made, scientific contributions of undoubted merit must be rejected, solely on financial grounds. An attempt to meet the difficulty is being made by the creation of a Publications Fund, to which the Council has already allocated sums amounting to more than £2000, and for which, it is hoped, further gifts will be earmarked in due course by fellows and others interested in this vital branch of the Society's activities. Papers submitted to the Society are already stringently 'refereed,' but the increasing claims made upon all publishing societies suggest that if publishing is to keep pace with production radical changes must take place in the form in which results are presented, so that while the main lines of investigation and the finished conclusions appear in scientific journals, the masses of detail and data, which at present occupy so much space, may be eliminated and yet be made available for consultation by scientific workers by being stored in manuscript form in recognised and specified scientific libraries.

AN exhibition designed to show the practical applications of recent scientific research work in the woollen and worsted industries was opened by Lord Novar in the Royal Scottish Museum, Edinburgh, on June 16. Lord Novar pointed to the need of closer co-operation between manufacturer and sheep-master, so that the latter might be aware of the exact requirements as regards grade and quality demanded for manufacturing purposes, with the view of breeding towards well-defined standards in these respects. He also indicated the important part research, conducted on scientific lines, has taken and is likely to take in furthering the aims both of breeder and manufacturer. The exhibits, which have been arranged by the British Research Association for the Woollen and Worsted Industries, cover a wide range, from samples of wool illustrating the characteristic qualities of various breeds of sheep and of some of their crosses, to delicate apparatus designed for the examination of spindles in rapid motion, for the testing of moisture content, elasticity, resistance to strain, etc., an ultraviolet radiation lamp by which faults of contamination may be readily detected, and a series of finished products illustrating common defects of manufacture and the methods by which they may be eliminated. The exhibition shows the purely scientific as well as the practical side of the work of the Research Association, which is to be congratulated on the great progress it has made and on its initiative in bringing to the notice of the public and the specialist these particular developments of scientific research.

AN exhibit of outstanding historical importance has just been added to the national collection at the Science Museum, South Kensington, through the generosity of Sir Charles Parsons and the directors of the Parsons Marine Steam Turbine Co., Ltd., who have presented to the nation the machinery and a portion of the hull of the epoch-making steam yacht *Turbinia*. This vessel ranks in historic interest with Patrick Miller's boat of 1788, Bell's *Comet* of 1812, and Pettit Smith's *Archimedes* of 1840, and no more suitable place for her could be found than in the museum which already possesses Symington's engine for Miller's boat and the engine of the *Comet*. The Parsons Marine Steam Turbine Co., Ltd., was formed in 1894 to test the application of the steam turbine—which had been in use ashore for ten years—to the propulsion of vessels, and the *Turbinia* was their experimental craft. Of 44½ tons displacement, 100 ft. long, her machinery developed no less than 2000 H.P. and gave her a speed of 34½ knots, or four knots faster than any other vessel of her day. Her performances at Spithead during the Diamond Jubilee review astonished the whole Navy. Though the majority of steam vessels afloat are still fitted with reciprocating engines, steam turbines are used in practically all high-speed vessels, in the majority of liners, and without exception in battleships, cruisers, and destroyers. The *Turbinia*, indeed, led directly to the *Hoods* and *Mauritanias*, and as such marks an epoch in the development of marine engineering second to none in importance.

PROF. GEORGE A. GIBSON, who has just resigned from the chair of mathematics in the University of Glasgow, was born at Greenlaw, Berwickshire, in 1858. He received his mathematical education at Glasgow under Prof. Jack and Lord Kelvin, and at Berlin under Kronecker and Weierstrass. From 1883 until 1895 he acted as assistant and lecturer in mathematics in the University of Glasgow. During that period he originated and conducted numerous special courses of lectures for honours students on advanced mathematical subjects, both pure and applied. In 1895 he was appointed to the chair of mathematics in the Royal Technical College, Glasgow, and in 1909 was recalled to the University as professor of mathematics. In the eighteen years during which he has held the chair, he has been to his staff an example of devotion to duty and to his students a great teacher. As the source and centre of a school of mathematics in Glasgow, he has expanded the scope and raised the standard of mathematical study in the University, fostered original research, and stimulated and encouraged the publication of many treatises on higher mathematics. Prof. Gibson has himself made valuable contributions to the theory of Fourier series and to other mathematical subjects. He is an authority on the history of mathematics, and has written important memoirs on famous Scottish mathematicians. He is the author of several well-known text-books, his "Treatise on the Calculus" being a standard work used throughout the British Empire. Prof. Gibson has always taken a keen interest in secondary education, and has rendered valuable services to the teaching of elementary mathematics in Scotland. He has been a conspicuous figure in the history of the Edinburgh Mathematical Society, and in 1902 he was elected an honorary member in recognition of his services and of his eminence as a mathematician. From 1917 until 1920 he held the office of vice-president of the Royal Society of Edinburgh, and in 1905 the University of Edinburgh conferred on him the degree of LL.D.

FOR some time past the problem of providing more adequate accommodation at Bedford College, London, for the greatly increased number of students, has been receiving attention. The present buildings were intended for 450 students only, while the College contains now 600. Six years ago, as a temporary measure, a new chemical laboratory was constructed out of old army huts. While never really adequate for their purpose, these relieved the more immediate pressure in one department but did not touch the growing needs elsewhere: they are now at the end of their life, and replacement before they are overtaken by complete dissolution has become urgent. It was decided to erect a new permanent building to meet the present needs, and the first step towards the materialisation of this project was taken on June 9 when Princess Mary, Viscountess Lascelles, visited Bedford College in the afternoon and laid the foundation-stone of the new wing. The existing science departments form the two wings of an open quadrangle, and it is proposed that the new extension shall occupy a position to the south-west to join on to these and so form the fourth side of an enclosed quadrangle of about 150 feet by 120 feet. The total cost of the scheme is estimated at not less than £110,000, towards which there is in hand approximately £53,000. Beyond this limit it is impossible for the College to raise further sums from its own resources, and an appeal is therefore being made to the public for aid. The new building is designed to provide a laboratory of inorganic and physical chemistry in place of the army huts, a lecture-hall to accommodate 600 persons, a department for geography, additional space for physics, zoology, history, French, etc., and also much-needed additional students' cloak-rooms. On the roof there will be a small astronomical observatory. After the ceremony of laying the foundation-stone, Sir Hildred Carlile, president of the Extension Fund, made a statement as to the documents to be placed under the stone. These latter included a current copy of the *Times*, the College Calendar, coins of the realm, and other contemporary objects. After the ceremony, Her Royal Highness visited some of the science departments, the library, and the residence wing.

LAST week Corpus Christi College, Cambridge, celebrated the two hundred and fiftieth anniversary of the birth of the Rev. Stephen Hales, who was born in 1671, died in 1761, and was buried in the south transept of Westminster Abbey. In an appreciation of Hales in the *Times* of June 17, Dr. Monckton Copeman refers to Hales as one of the most remarkable of the many distinguished men that Corpus has produced. For fifty years Hales was perpetual curate of Teddington, and it was there he wrote his "Vegetable Statics" of 1727. His portrait is given in Schuster and Shipley's "Britain's Heritage of Science." A fellow of the Royal Society, a foreign member of the Paris Academy of Sciences, and one of the enthusiastic supporters of the Society of Arts, Hales' scientific work took a practical turn, and he was instrumental in improving the ventilation of ships and prisons, his work on which entitles him to be called a public health pioneer.

THE *Chemiker-Zeitung* of June 4 contains an interesting account of the thirty-second annual conference of the Bunsen Society for applied physical chemistry, which was held in Dresden on May 26-29, under the presidency of Dr. Mittasch of Ludwigshafen. In recent years it has been customary to make a special study of a particular branch of the subject, the theme chosen for this year being electro-chemical problems. Papers were read dealing with a variety of topics, *e.g.* electrical insulators, the corrosion of metals, the passivity of metals in alkaline media, the electrolytic separation of magnesium from complex fluorides, the influence of adsorbed ions on the sensitiveness to light of silver bromide, electrolytic processes in the alkali industry, etc. Prof. Billiter, of Vienna, in dealing at some length with the electrolysis of sodium chloride, pointed out that chlorine, instead of being a by-product of the manufacture of caustic alkali, has recently become more valuable than the latter, owing to its application, particularly in Italy, to the manufacture of cellulose.

IN a pamphlet issued by the English Electric Co. describing electric locomotives for every-day haulage work in factories, a strong case is made out for their wider adoption. At the present time when wages are high and fuel is dear, any saving effected in either has a marked influence on production costs. In many works steam locomotives are used. Before the locomotive goes into service, steam has to be raised, necessitating the attendance of a fireman. The bunkers have to be filled and water must be taken on board. During service, consumption of fuel continues even when the locomotive is not usefully employed. In the majority of cases this standby loss is considerable. After service the fires have to be drawn and the ashes cleared away. Repairs and renewals are frequent, and during this time the locomotive represents capital lying idle. On the other hand, the electric locomotive is immediately ready for use, there are no standby losses, and it needs little attention. It will also for short periods sustain a heavy overload, and thus the rated horsepower of the locomotive may be much less than when steam is used. In general two electric vehicles can supersede three steam locomotives. The electric power is obtained either from self-contained batteries or from an overhead line, the latter method being as a rule the more economical. As all modern works have some kind of electric supply available, there seems no reason why electric traction should not be more widely used.

THE seismograms of the great Chinese earthquake of May 22, obtained at nine observatories in North America and at Honolulu, have recently been studied by Commander N. H. Heck (Science Service News Bulletin). He places its epicentre in lat. 35° N., long. 100° E. or some distance to the west of the position given in our previous note (NATURE, June 4, p. 826), and still farther to the west of that of the great earthquake of Dec. 16, 1920. It thus lies either in western China or eastern Tibet. It is worthy of notice that the faults in this district have a general east-and-west direction. No details of the earthquake have yet reached us, but it will be remembered that three months elapsed before the outside world knew of the earthquake of 1920, in which about a hundred thousand lives were lost.

THE International Union of Geodesy and Geophysics has published volume 3 of the Proceedings of the Section of Geodesy at the meeting of the Union held at Madrid in October 1924. This bulky volume consists of the reports on the geodetic work of various countries adhering to the Union. These reports, which are mainly in French and English, were presented to the meeting and are now bound together for convenience of reference. For the most part they cover work done between 1922, the date of the previous meeting at Rome, and 1924, but a few contributions include additional papers such as one by Mr. J. H. Cole, of the Survey of Egypt, on errors in spirit levelling, another on changes of levels caused by the Japanese earthquake of 1923. The volume embraces reports from the chief European States except Great Britain, Germany, and Austria, and also from Canada, the United States, Mexico, Japan, and Siam.

A section of experimental biology in which tissue culture figures prominently has been planned for the tenth meeting of the International Zoological Congress which meets in September in Buda-Pesth. So far as we are aware, this is the first time that tissue culture has practically a whole section devoted to it at an international scientific gathering. Numerous papers and demonstrations figure on the programme. Prof. Ross Harrison, who may be regarded as the founder of tissue culture, will very appropriately open the proceedings on Sept. 5, and Drs. Carrel, Warren H. Lewis, Levi, Lumsden, and Maximow are among the workers who are contributing papers. There will be special discussions on the bearings of pathology on tissue culture (Sept. 7), and on vital staining (Sept. 8). Prof. Rhoda Erdmann, herself a distinguished worker in the sphere of tissue culture, is to be congratulated on her initiative in preparing a very interesting programme.

At the meeting of the executive board of the U.S. National Research Council the following general officers were elected: *Chairman*, Gano Dunn, president of the J. G. White Engineering Corporation, New York City; first vice-chairman, Prof. T. H. Morgan, president of the National Academy of Sciences; second vice-chairman, Dr. John C. Merriam, president of the Carnegie Institution of Washington; third vice-chairman, Prof. R. A. Millikan, California Institute of Technology, Pasadena. The permanent secretary of the National Research Council, Dr. Vernon Kellogg, and the treasurer of the Research Council, Dr. George K. Burgess, director of the Bureau of Standards, continue in these offices. The following new members of the executive board were elected: Prof. James F. Norris, professor of organic chemistry, Massachusetts Institute of Technology, Cambridge, Mass.; Prof. F. R. Moulton, professor of mathematics, University of Chicago; and John R. Freeman, consulting engineer, Providence.

Volume 19 of the Collected Research of the National Physical Laboratory, Teddington, is a quarto of 444 pages and is devoted to the work published by the Physics Department of the Laboratory during the years 1920–25. A large proportion of the papers deal with the heat-insulating properties of materials which are used or may be used in the construction of refrigerator chambers, and with the heat which is transferred to or from bodies by the convection currents they set up in the air surrounding them. Hygrometers suitable for use in cold-storage chambers are thoroughly discussed and new instruments described. High vacuum mercury condensation pumps have been considerably improved by the staff of the Department, research in the direction of establishing the composition of the X-rays from various metals and of using the rays to analyse alloys and other substances has been continued, and some advance made towards the more efficient protection of the X-ray worker. The volume is full of most valuable information, and it shows clearly how much can be done for science and industry by ten or twelve active workers in a well-equipped laboratory.

Too much caution cannot be exercised in naked-eye observations of the sun and its total eclipse on Wednesday next, June 29. Several contributors to our supplement last week referred to the danger of looking at the sun through unsuitable glasses or screens before totality. If, however, it is desired to observe the passage of the moon over the sun's face, no better device could be used than the "Combined Dark-Adaptation Mask and Graduated 'Eclipsia' Screen," made at the suggestion of Dr. R. L. Waterfield and sold by Messrs. Theodore Hamblin, Ltd., 15 Wigmore Street, London, W.1 (price 5*s*.). By means of a film of varying density, it will be possible to look at the sun from time to time before totality, and during total eclipse to observe the corona without any screen at all. The device should be very useful to all who are arranging to watch the eclipse on Wednesday next.

The annual conversazione of the Institution of Electrical Engineers will be held at the Natural History Museum, South Kensington, on Thursday, July 7, at 8.30-11.

Applications are invited for the following appointments, on or before the dates mentioned:—A lecturer in chemistry at the Leicester College of Technology—The Registrar, Colleges of Art and Technology, Leicester (July 1). An assistant in electrical engineering at the Crewe Technical Institute—The Director of Education, County Education Offices, City Road, Chester (July 2). An analytical assistant in the laboratory of the Public Analyst and Chemist to the Council of the Borough of Stepney—The Town Clerk, Municipal Offices, Raine Street, E.1 (July 4). An assistant examiner in the Standards Department of the Board of Trade—Principal Establishment Officer, Board of Trade, Great George Street, S.W.1 (July 6). A principal of the L.C.C. School of Building, Ferndale Road, Clapham—The Education Officer (T.1.a), The County Hall, S.E.1 (July 9). An assistant lecturer in philosophy at the University College of Swansea—The Registrar, University College, Singleton Park, Swansea (July 9). Research chemists at the Building Research Station, Garston, Herts; the Chemical Research Laboratory, Teddington; the Fuel Research Station, East Greenwich, and local stations of the Physical and Chemical Survey of the National Coal Resources—Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1 (July 11). Research Physicist at the Building Research Station, Garston, Herts—Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1 (July 11). An assistant government chemist under the Sudan Government—The Controller, Sudan Government London Office, Wellington House, Buckingham Gate, S.W.1 (July 14). A glass-blower for the Egyptian University, Cairo—The Director, Egyptian Educational Office, 39 Victoria Street, S.W.1 (July 14). A junior scientific officer for the Air Ministry Scientific Research Staff, primarily for research work in the aerodynamics department of the Royal Aircraft Establishment—The Chief Superintendent, R.A.E., South Farnborough, Hants (July 16, quoting A.180). A zoologist and a hydrologist for the *Discovery* Expedition—The Private Secretary (Appointments), Colonial Office, 38 Old Queen Street, S.W.1 (July 16). A research entomologist at the Long Ashton Fruit Research Station—Registrar, University, Bristol (July 16). An assistant lecturer in geology—Registrar, University, Manchester (July 16). A live-stock officer and an assistant agricultural officer for the department of agriculture, Kenya Colony—The Private Secretary (Appointments), Colonial Office, 38 Old Queen Street, S.W.1 (July 31). A lecturer in physics at University College, London—The Assistant Secretary, University College, Gower Street, W.C.1. An assistant teacher in the engineering department of the Woolwich Polytechnic—The Principal, Woolwich Polytechnic, S.E.18. Laboratory attendant for botanical department of University College, Leicester—Dr. E. N. Miles Thomas, 8 Inglewood Mansions, West End Lane, London, N.W.6.

Our Astronomical Column.

Comets.—Comet Pons-Winnecke, 1927*c*, is now very near the earth; on the night of June 26-27 it will approach within about 3½ million miles, which is closer than any cometary approach within living memory. Since, according to Mr. B. M. Peek, the nucleus is well-defined, it is worth while to take carefully timed photographs with the view of determining the solar parallax. The comet should be faintly visible to the naked eye as a large ill-defined area of faint luminosity. Its apparent motion will be as rapid as that of the moon in apogee.

Mr. B. Stromgren has revised the orbit, using observations up to June 10, and obtains:

$$T = 1927 \text{ June } 21{\cdot}064 \text{ U.T.}$$

$$\left.\begin{array}{l}\omega = 170°\ 22'\ 35{\cdot}0'' \\ \Omega = 98\ \ \ 8\ \ 34{\cdot}3 \\ i = 18\ \ 56\ \ 25{\cdot}9\end{array}\right\} 1927{\cdot}0$$

$$\log e = 9{\cdot}836076$$
$$\log a = 0{\cdot}519227$$
$$\log q = 0{\cdot}016698$$

Ephemeris for 0^h U.T.

	R.A.	Decl.	log r.	log Δ
June 23.	19^h $16{\cdot}6^m$	37° 41′ N	0·0169	8·699
25.	20 10·1	24 21	0·0173	8·623
27.	21 3·7	5 54 N	0·0181	8·591
29.	21 52·2	12 2 S	0·0192	8·633

On June 23 the comet is some 7° east of Vega; on June 24, 5° north-east of β Cygni; on June 26, in the diamond formed by the bright stars of Delphinus; on June 27, near α Equulei. It then runs rapidly southward and quickly passes out of our reach, but it will be followed in Australia and South Africa. Perturbations by the earth will have to be applied in further researches on its motion:

Continuation of the Ephemeris of Comet 1927*d* (Stearns) for 0^h (*Pop. Ast.*, June-July).

	R.A.	N. Decl.	log r.	log Δ.
June 24.	14^h 1^m 21^s	22° 55′	0·577	0·530
July 2.	13 59 40	23 34	0·579	0·547
10.	13 59 10	24 0	0·581	0·563
18.	13 59 47	24 19	0·584	0·579

Magnitude 10 to 11.

Continuation of the Ephemeris of Comet 1927*e* (Grigg-Skjellerup) for 0^h.

	R.A.	N. Decl.	log r.	log Δ.
June 25.	16^h 33^m 30^s	50° 40′		9·462
29.	16 53 40	46 30	0·0548	9·502
July 3.	17 10 30	42 21		9·541
7.	17 23 0	38 43	0·0679	9·579
11.	17 33 0	35 28		9·616

Magnitude about 11.

A Fireball on June 10.—Mr. W. F. Denning writes that "a fireball, estimated to be twice as bright as Venus, was observed from Boscombe in the strong twilight on June 10 at 9^h 3^m P.M. G.M.T. It passed from about 20° below the Polar Star towards the east through the stars in the lower part of Cygnus, its path slightly falling during the five seconds the object remained in view. It left a short trail, and was apparently directed from a radiant point in the western sky. The fireball must have been a very brilliant object as seen from the central and eastern counties of England, but no report of its appearance has been received from those parts.

"It is hoped that further descriptions of its flight amongst the stars will be communicated, for the fireball was one of the most interesting and conspicuous kind, though the prevailing twilight must have considerably moderated its brilliancy."

Photographs of Mars.—Lick Observatory Bulletin 387 contains a series of photographs of Mars taken in 1924 by R. J. Trumpler. Yellow and red screens were used on the 36-inch refractor, and the plates were bathed in pina verdol. The plates were used to determine the diameter and polar flattening; the diameter was got both from limb measures and from measures of markings on the disc at different times, the rate of rotation being well known.

The limb measures gave (for unit distance):

	Yellow Screen.	Red Screen.
Equatorial diameter	9″·41	9″·33
Polar diameter	9″·32	9″·24
Polar flattening	1/96	

The measures of disc markings gave:

	Yellow Screen.
Equatorial diameter	9″·178
Polar diameter	9″·075
Polar flattening	1/89

It is concluded that the flattening exceeds the value 1/190 deduced by H. Struve from the Satellites.

Rare Astronomical Books.—A sale catalogue of more than usual interest just issued by Henry Sotheran and Co. includes the library of the late Dr. Dreyer. There is an extensive collection of books by Sir Isaac Newton, and by others relating to his work. A specially interesting work is the copy of Euclid's elements used by Newton when he commenced the study of geometry as a sub-sizar at Trinity College. This contains numerous MS. notes of his, which are said to have been written at various periods of his life; they express many of the propositions in algebraic notation. This work is valued at £500. Copies of the first edition of the "Principia" (first and second issues) are valued at £35 and £42 respectively. The second edition is only £2 : 5s.

Research Items.

Australian Stone Implements.—A paper on stone implements found on the camping grounds formerly used by Australian aborigines, by Mr. A. S. Kenyon, in *The Victorian Naturalist*, vol. 43, No. 10, which describes the character of these implements and their uses, suggests certain general considerations which are not without interest to students of the use of stone in prehistoric times in other parts of the world. The Australian camping grounds are of three types—those of a purely temporary character, where the remains are of food entirely; those where good shelter and varieties of food were obtainable, but here implements are sparse and of a crude nature; and thirdly, those that were permanent and at which aborigines were always to be found, and where the old men and women stayed and practised their arts and crafts. The first evidence of a camping ground is the presence of foreign stones, which may be either implements or fire stones; and the second the presence of food remains, often large quantities of shell of an edible kind. Raised beaches, especially around Port Phillip, have often been mistaken for kitchen middens. Examination reveals that the foreign stones fall into the following groups, apart from fire-stones: (*a*) small but definite shapes, mostly retouched; (*b*) larger shapes, much less definite, with secondary working of a much coarser nature; (*c*) similar flakes without retouching; (*d*) large pieces with coarse chippings; (*e*) cores. By far the greater number show no sign of working, but cannot be classed as 'wasters.' The aboriginal did not spend time on the elaboration of an implement when once he had obtained the edge he required, and it was thrown away perhaps after a few strokes, when once the edge showed the effect of use.

Man's Place of Origin.—In the issue of the *Scientific Monthly* for May, Dr. William K. Gregory surveys the evidence bearing upon the antiquity of man in its relation to the question of his place of origin, inclining strongly to the conclusion that it must be sought in Asia. He naturally attaches considerable importance to the discovery in 1921 in a cave at Chou Kou Tien, south-west of Peking, of the two human teeth (premolar and molar) of Upper Pliocene or Lower Pleistocene age. The close relation in structure between, say, man and the chimpanzee points, in view of the high estimate of geologic time accepted by some authorities, and the slow and unequal rate of evolution apparent when the palæontological data are studied comparatively, to a separation at a period far later than the Lower Eocene. It also supports Darwin's view that man is an offshoot of the primates of the Old World rather than the New. In the Old World, notwithstanding the close approach to human conditions of *Dryopithecus rhenanus* of the European Pliocene, and the provenance of the most primitive known skulls (Piltdown, Heidelberg, etc.), Europe is not a likely place of origin. Notwithstanding the occurrence of members of the man-anthropoid series in the Lower Oligocene of Egypt, central Asia affords the most likely geological evidence of suitable avenues of distribution—this conforming with the peripheral distribution of Pithecanthropus and the Wadjak and Australian skulls, while the Nebraska tooth probably represents a migrant from eastern Asia. The geological, palæontological, and anthropological data from central Asia have suggested the hypothesis that a gradual uplift of this area afforded the cause and the conditions of a gradual evolution of man in group after group of higher types, the lower migrating continuously on the receding lines of the changing environment.

Mediæval Anatomical Texts.—The subject of mediæval anatomy to which we directed attention some time ago (Nature, Dec. 5, 1925, p. 811) has recently been brought before us again by Dr. George W. Corner, professor of anatomy in the University of Rochester, U.S.A., in a scholarly treatise which contains a commentary and translation of the more important anatomical texts as well as a bibliography and facsimiles of some of the manuscripts. Dr. Corner has skilfully disentangled the historical facts from the legendary matter connected with the school of Salernum and Constantine the African, whom, like Sudhoff, he regards as one of the founders of modern medicine and indeed of all modern biology. Dr. Corner emphasises the fact, which does not appear to be sufficiently realised, that the translations of Constantine and the school of Salernum gave the Occident some of the fruits of Oriental medicine a hundred years before the later Arabic philosophers and physicians were translated at Toledo. The anatomical texts of the twelfth century consisted partly of three documents known as the two Salernitan demonstrations, one of which was called "Anatomia Cophonis," and "Anatomia Mauri," which were used as practical manuals for teachers and students, and partly of systematic descriptive anatomical works, in which the subject is handled in a highly organised style in accordance with the fashion of mediæval scholasticism. Dr. Corner also gives an interesting account of a thirteenth-century text of a work named "Anatomia Vivorum" or "Anatomia Ricardi Anglici," which he regards as one of the very first books of the Middle Ages to show the influence of Aristotelian biology.

Foraminifera from the Suez Canal.—The Cambridge Expedition to the Suez Canal in 1924 collected Foraminifera at nine stations, lying between the Great Bitter Lake and Gulf of Suez, and they are discussed by E. Heron-Allen and A. Earland in *Trans. Zool. Soc. London*, vol. 22, Part I., No. 9, Dec. 1926. The gatherings were not large and yielded few species, most of which belonged to the 'porcellanous' group. There is no evidence of movement of any species from north to south (*e.g.* from the Mediterranean through the Red Sea), but there is thought to be positive evidence of one Indo-Malay and South African species—*Polystomella Milleti* H.A. and E., also found at Suez—migrating northwards, although only represented from the Bitter Lake by one specimen. A single specimen of *Polystomella craticulata* (Fichtel and Moll) occurring in the Bitter Lake is regarded as almost equally strong evidence of northward migration of that species. It is, however, hazardous to draw conclusions from single specimens, and under the heading 'Known Distribution,' P for Palermo is given (perhaps a misprint), although in the text it is stated that *P. craticulata* has not, so far as the authors are aware, been recorded from the Mediterranean. It is interesting that nearly all the Suez Canal specimens of Orbitolithes are abnormal in some way, a peculiarity attributed to the variations in salinity which are apparently productive of deformed and monstrous growth. Three species are recorded, but all differ somewhat from the types, the usual specific characters being more or less obliterated. There is a list of the species of Foraminifera collected comprising 50 in all, 38 being taken in the Bitter Lake and the remainder at the southern entrance of the Canal. Of the 38, 5 are known from the Indo-Pacific and not from the Mediterranean, and the remainder are from both areas.

A New Mutant in Datura.—In the experiments of Drs. C. S. Gager and A. F. Blakeslee (*Proc. U.S. Nat. Acad. Sci.*, vol. 13, p. 75) mutations appear to have been produced by the action of radium emanations on the ovary of the plant *Datura Stramonium*. In the successful case an exposure of 10 minutes, probably just after the reduction divisions in the ovules, resulted in 17·7 per cent. of mutations among 113 plants, whereas the normal rate of mutation is about 0·47 per cent., and an untreated capsule of the same plant gave 36 offspring, all normal. The mutants were mostly forms with an extra chromosome, but included two new gene mutants (found in the offspring of 18 plants tested) and a peculiar type called 'nubbin.' The latter has an extra chromosome, but from various lines of evidence Blakeslee concludes that its composition probably includes two chromosomes each made up of the halves of different chromosomes. Unlike the other trisomic mutants, 'nubbin' gives rise to five different types in its offspring. The radium treatment is held to be 'largely responsible' for all three types of mutation obtained.

Plant Ecology of Porto Rico.—Volume 7, parts 1 and 2, of the "Scientific Survey of Porto Rico and the Virgin Islands," published by the New York Academy of Sciences, is devoted to an account of the ecology of Porto Rico by H. A. Gleason and Mel I. Cook. This work of 173 pages and 50 excellent photographic plates is the result of a few months' field work on the island. All the principal types of vegetation over some 3400 square miles of country were examined, and the results are given as purely those of a field survey, but as such form a good basis for more intensive work of a statistical or experimental nature. Works on island floras (*e.g.* Cooper's "Climax Forest of Isle Royale") are of a special interest from a successional point of view, as factors can be delimited in a manner scarcely possible in the case of continental floras. The authors distinguish three distinct vegetation regions, that of the Northern Coastal Plain, that of the Central Mountain Region, and that of the Southern Coastal Plain. Most of the first region is covered with limestone deposits, which develop a mesophytic upland forest, now nearly destroyed by settlers. Besides these mesarch associations, xerarch, hydrarch, and halarch series are found, the latter in the form of mangrove swamps, and all of those tend towards the development of a Playa Land Climax Forest. The Central Mountain Region was originally entirely covered by forest, except for minor areas of rock outcrops. The forest comprises five ecological types, in which the causal factors seem to be altitude, rainfall, and exposure. Only fragments of lower level forest now remain, but the vestiges show strong floristic relationship to the xerophytic forest of the Southern Coastal Plain. Between 2000 ft. and 3000 ft., the forest is mesophytic in character, consisting of a moist tropical forest and a tropical rain forest. The higher peaks are clothed by the Sierra palm forest and the mossy forest, the two types being differentiated chiefly by their exposure to wind. Each of these five ecological types is associated with a definite set of climatic conditions, which are not subject to modification by the vegetation, and each may thus be regarded as a climatic climax formation. A vegetation map would have been an acquisition to the work.

The Lias of the Median Pré-Alps.—The nappe of the Median Pré-Alps has been referred by different authors in turn to each of the three zones of sedimentation—Helvetian, Pennine, and Austro-Alpine—which have contributed to the great recumbent folds of the western Alps. A very careful study of the stratigraphy and fauna of the Lias of the difficult region south of Lake Geneva has been made by E. Peterhans, and his results are published in the *Mémoires de la Soc. Helvétique des Sci. Nat.*, vol. 62, 1926, Mem. 2. It is clearly shown that the Liassic fauna of the "Medianes" is definitely different from those of the Helvetian and Austro-Alpine regions, and that it probably belongs to the Pennine region. The latter deduction, however, cannot be directly proved, for the corresponding rocks of the Monte Rosa nappe are thoroughly metamorphosed. The provisional assumption by some of the Swiss geologists that the "Medianes" represented an extreme north-westerly thrust of the Austro-Alpine nappes, had to face the difficulty that the folding of the "Medianes" is of a type that implies the former presence of a heavy cover. It is now possible to regard this vanished cover as an Austro-Alpine nappe, part of which still remains in the inner belt of the Pré-Alps. The most puzzling feature of Alpine architecture thus still remains, for the push of the Austro-Alpine nappes far to the north-west of their roots still awaits a mechanical explanation.

Climate and Animal Evolution.—In the memoir entitled "The Environment of Tetrapod Life in the Late Paleozoic of Regions other than North America," published by the Carnegie Institution of Washington, Prof. E. C. Case continues that study of the land animals of Permian time and of the environment in which they lived which has occupied him for some twenty years and formed the subject of those well-known works on the American Permian fauna to which the present volume forms a supplement. Prof. Case holds that, within any restricted period of time, correlation of beds by conditions of environment is a more satisfactory method of understanding the relationships of faunas than is an attempt to establish correlations on the basis of an equivalence with marine deposits. In his former work, Prof. Case was able to show that the animals which form part of the 'Texas' Permian fauna are constantly associated with definite conditions of the environment in which the rocks containing their remains were laid down. He has now added to his very great experience of the American Upper Palæozoic an acquaintance with rocks of similar age in many other parts of the world, founded not only on the literature, but also on a personal examination. The resulting work is most valuable because it brings together in a well-arranged form a vast mass of information on the geology and palæontology of the continental Permian deposits of the rest of the world and discusses the conditions under which they have been laid down. The most interesting general conclusion is that the evolution which takes place in the members of a fauna must be associated in some way with the concurrent climatic changes in the area in which they are living.

Mississippi Floods.—The slow sinking of the lower Mississippi valley was suggested as a cause of the floods by Dr. D. E. White at the recent meeting of the American Shore and Beach Preservation Association. According to a report issued by Science Service of Washington, Dr. White pointed out that while there is no certainty that the gulf coast is sinking, the undoubted downward movement of the Atlantic coast is significant. The region to the north of the great lakes is being tilted upward, which suggests that farther south there may well be an area of depression probably with some warping or twisting of the earth's crust. He cites the well-known occurrence of earthquakes in the Mississippi valley between Cairo and Memphis as probable confirmation of this movement. The rate of sinking, if it occurs, is no doubt very slow, but it will cause an increasing liability to floods, and furthermore, by reducing the speed of the currents, will render it more difficult for the lower river to keep its bed clear of sediments. Dr. White raised another problem with regard to the silting up of river channels. The levee system is based on the assumption that streams so confined will scour their own channels, but this, he maintains, has not been proved. If the river really drops its load of silt in the bed instead of carrying it out to sea, eventually the bottoms will be higher than the banks, and the raising of the levees to keep pace with this growth will cause increasing peril to the lowlands. Dr. White advocates the national importance of a study of these problems.

GEOPHYSICS IN THE UNITED STATES.—The report of the seventh annual meeting, on April 29–30, 1926, of the American Geophysical Union, has recently been issued as Bulletin No. 56 of the National Research Council. More than a hundred of its 134 pages are devoted to reports and summaries of papers read in the six sections and the general meeting. They afford a valuable and interesting record of American views on the problems of geophysics as a whole, and of their activities and observations within their own large and important field of work. At the general meeting the constitution of the earth was discussed, in the light of cosmical theory, gravity measurements, seismic and magnetic data, and chemical investigation. The section of volcanology also instituted a symposium, not confined to its own special viewpoint, on co-operation in the scientific investigation of the Aleutian Islands. Many papers in the remaining sections dealt with recent instrumental advances and programmes of observation completed or in progress.

THE PHOTO-ELECTRIC PROPERTIES OF MERCURY.—A number of troublesome effects produced in photo-electric work by impurities have been made the subject of a special study by H. K. Dunn. The experiments, carried out under the direction of Prof. Millikan and described in the May number of the *Physical Review*, were performed under conditions similar to those employed in the standard determination of the photo-electric threshold of mercury, with a continually renewed surface, and have incidentally confirmed Kazda's value of 2735 Å.U. for the limit. When the surface-flow was stopped in a high vacuum, the threshold rose quickly to 2850 Å.U., and then in the course of a few days fell to 2680 Å.U. If liquid air was not kept on the traps, radiation of still higher frequency was required. The contamination seemed to be due to some relatively non-volatile substance other than water, which was given off by the tap-grease used. With pure hydrogen over the surface, the behaviour was exactly the same, but the presence of hydrogen which had been distilled with the mercury and was apparently in solution in the metal, greatly retarded the rate at which the active impurity became effective. It is suggested that in this case, as well as in other instances where the photo-sensitivity of a plate has been found to be increased by electrolytic generation of gas on the side remote from that exposed to the radiation, undesirable impurities are carried off by the gas diffusing through the substance.

MOVING MAGNET GALVANOMETERS.—Dr. C. V. Drysdale, in the May number of the *Journal of Scientific Instruments*, points out that recent improvements in the design of moving magnet galvanometers have made them for many purposes superior to moving coil galvanometers. By improving the design of the moving system and using cobalt steel magnets of very small dimensions, A. V. Hill and A. C. Downing have succeeded in making galvanometers about 500 times as sensitive as Kelvin four-coil galvanometers. The most serious drawback to moving magnet galvanometers is their susceptibility to magnetic disturbances. This difficulty has been overcome by using a thin cylinder of the new high permeability nickel iron alloy which is generally known as mumetal or permalloy. A simple experiment is described showing the effective nature of this screening. A light cobalt steel magnet suspended by a quartz fibre was found to oscillate with a period of one second in the earth's field and was very sensitive to the motion of a bar magnet at some distance away. When it was screened by a permalloy cylinder closed by plates of the same metal, the time of oscillation was increased to more than ten seconds and the effects of the external bar magnet were negligible. The screening results obtained are far better than those got in the ordinary way by using massive soft iron bells. A notable advance has therefore been made.

CORROSION OF METAL JOINTS.—In the *Journal of the Royal Society of Arts* for April 29, Dr. U. R. Evans discusses briefly the problem of corrosion in general. After the consideration of troubles arising in welded, riveted, or soldered joints, the paper concludes with the following: The choice of materials which are to come in contact at a joint should be made with a view to minimising the E.M.F., although in some cases it may be advisable to make the metal presenting the smaller area weakly cathodic to the other. The nature of the joint itself is important, and care should be taken to avoid crannies which will be anodic to the main surface. Perhaps the most dangerous condition is a capillary crevice existing between the two dissimilar metals. Here the portion of the surface of the nobler metal near the mouth of the crevice will function as the cathodic area, whilst inside the crevice the base metal, and often the noble metal also will suffer anodic attack. It is important whenever possible to apply some coating of efficient protective paint, varnish, or plastic composition to the joints, with special reference to places where microscopic crannies may exist. The possibility of bulging due to cranny-corrosion is another matter of which account must be taken, the size and strength of the pieces being chosen to resist the stresses exerted by the volume changes involved in the corrosion process. The paper contains an interesting discussion from the electro-chemical point of view of the soldering of aluminium.

POTASSIUM NITRATE AS A FERTILISER.—For the enrichment of artificial fertilisers, potassium nitrate appears to possess so many advantages over other compounds of nitrogen that extensive field experiments have been undertaken by the Agrikultur-chemische Versuchsanstalt der Landwirtschaftskammer in the province of Saxony and also in Cassel. The association of potassium with nitrogen in the salt renders it more valuable for this purpose than sodium nitrate, which also possesses the disadvantage of being much more soluble at the ordinary temperature. Since, however, the proportion of potassium to nitrogen is too great, the salt must be suitably mixed with other materials. In the *Chemiker-Zeitung* for May 7 is an account of the first year's experiments upon comparisons between potassium nitrate and other nitrogenous salts. The results seem promising, but it is too soon as yet to draw any definite conclusion. Further reports will be awaited with interest. The tests were carried out with winter-corn, oats, tobacco, potatoes, beetroot, etc., partly on the land and partly in pots.

Chemical Industry and Technical Institutions.

Mr. W. J. U. Woolcock, general manager of the Association of British Chemical Manufacturers, delivered a striking address to the annual conference of the Association of Teachers in Technical Institutions which was held at Plymouth on June 4-7. Dealing with technical education and industry, he illustrated his theme by reference to chemistry, pure and applied. With this in mind, he traced the growth of the British chemical industry, which is now, he said, among the six greatest industries of the country; £200,000,000 capital is invested in it; it employs a quarter of a million workers and is exceedingly well organised. Not very long ago its range was small and, in Great Britain, relatively unimportant: to-day it provides the largest field for the scientific chemist. It has made greater strides in its post-War development than any other British industry, and is of such a wide character that it is difficult to set limits to its boundaries.

Three new points are, however, to be noted. While at one time chemical industry was practically the only outlet for the trained chemist who desired to apply his knowledge to industry, there is now no industry which cannot be benefited by the application of scientific knowledge to its control and development. There is, therefore, an almost unlimited field for the technically trained man or woman. Again, the post-War developments have been specially remarkable. Actually, of course, we have always had some sort of chemical industry in Britain, but what is called chemical industry is really an aggregation of a number of industries in many of which we have held our own for more than half a century. Particularly is this true of what are known as the heavy chemical industries. But since the War we have developed and maintained the fine chemical industries such as dyestuffs (the Dyestuffs Act helped considerably), research, medicinal, and photographic chemicals. We are therefore able to speak now with America, Germany, France, or Switzerland in brotherly terms, not in the terms of the poor relation.

There remains a third point, which refers to the boundaries formerly set between scientific and 'non-scientific' industries. Already it has been pointed out that there is no industry which cannot be benefited by scientific methods; it is also true that there is a number of industries doomed to extinction if such methods be neglected. "Thus," said Mr. Woolcock, "I say not only to the chemists here, but to the physicists, electricians, and especially to the biologists, that whatever industry you enter, or whatever part you have to play in teaching those who may become industrialists, yours is a great vocation. I use no words of exaggeration when I say that the future of this country can be very largely influenced by what you can do." He was not concerned at the moment, he said, with the philosophical implications of technical education. He wanted to look at it from the viewpoint of what sort of men and women it produces—a test upon which technical teachers should be prepared to be judged. After all, the business man has to fit the product of teaching into the realities of his business. He can therefore recognise its good results in his own practical affairs, and he is bound to notice what appear to him to be its deficiencies.

On the whole, the present system gives satisfactory results, but there remain certain deficiencies to be made good. Mr. Woolcock would suggest that there is not available a sufficient number of trained scientific persons who have been taught from the point of view of economy. It is possible to teach the principles of chemistry and engineering in such a way as to inculcate throughout those conceptions of efficiency with regard to expenditure on material, labour, wear and tear of machinery and plant, heat, light, power, and so forth, which are essential to industry. It may be replied that this is already being done in some measure; but it must become far more general and must start quite early in the training of young scientific workers. An important aim, too, of technical education is the acquirement of ability in experiment, and by this is meant not only manipulative skill, but also imaginative conception. The teaching of manipulative skill is bound to vary in quality in accordance with the standard of the teacher. That cannot be avoided, but it is still possible that manipulative skill and manipulative conception can be developed in all their bearings from the point of view of their quantitative efficiency. From this it seems to follow that there is need to widen the scope of technical education. It might usefully include administration, costing, and production.

In his sketch of the development of the chemical industry, Mr. Woolcock said that, following the addition of fine to the heavy chemical industries, another development is taking place right under our eyes. It is a development along lines of production in enormous quantities of commonplace articles. "Undoubtedly," he said, "the industry has provided a bigger outlet than any other in the country for your students."

The New Experimental Station of the Safety-in-Mines Research Board.

The official opening on June 14 of the new Experimental Station of the Safety-in-Mines Research Board at Harpur Hill, near Buxton, is an event of much importance in the mining world. It was fitting that the ceremony should be performed by Lord Chelmsford, chairman of the Miners' Welfare Fund Committee, and should be welcomed in no uncertain tones by Mr. Herbert Smith, president of the Miners' Federation.

Lord Chelmsford, in his speech, made it clear that the assistance of the Welfare Fund had only been obtained on two conditions: (1) that the nature and locality of the Station should be approved by both the owners and miners, and (2) that the experimental plant and its scientific equipment should be the best that could be designed for the purpose. When the Committee was unanimous on these two essentials it had no difficulty in allocating a large capital sum for acquiring and equipping the site at Harpur Hill for the experiments which could only be carried out on a large scale, and for erecting at Sheffield buildings for laboratory researches especially connected with the properties of coal and with improvements in the miners' safety lamp. Besides this capital expenditure, an endowment fund of £250,000 had been invested to provide an annual income for the purposes of research.

The Committee, Lord Chelmsford added, did not suppose that immediate practical results would follow from a few scientific experiments; it is realised that the problem of securing safety in mines becomes more and more complex as the workings are extended, and it is only by the most patient research—not by one man, but by a trained staff working under skilled direction—that progress can be made. Fortunately, the country possesses in the Research Board a body of experts, administrative and scientific, who can advise on the work, and in Dr. Wheeler it has a director of research who commands the full confidence of the Board. What is eminently desirable is to maintain the closest touch between the mining industry and the Research Board. The public are deeply interested in the problems the Board has to solve, and it should not be beyond the wit of man to keep the public informed of the methods used and the results obtained in language which can be followed by ordinary folk unversed in scientific formulæ.

After the opening speech, the chairman, Col. Lane-Fox, the Secretary for Mines, called on Mr. Eustace Mitton on behalf of the Mining Association (in the absence through illness of the president, Mr. Evan Williams), and on Mr. Herbert Smith, president of the Miners' Federation. The latter at once struck a note to which the large audience were responsive. "There are two things," he said, "in regard to which coal-owners and miners are always friends—first, how to save life and limb, and secondly, how to rescue when life and limb are at stake." On that platform they stood as one. He warmly commended the Welfare Fund, and the work that had been done under the chairman's guidance. He admitted the difficulty of persuading miners that there is danger in coal-dust, and he recognised the importance of the artificial mine that demonstrated the destructive violence of a pure coal-dust explosion, but stated that the plant that appealed to him most as a Yorkshire miner was the building where artificial gob fires could be initiated and studied throughout their various courses.

On the new experimental station the most important sections of the research equipment are the two steel galleries which have been constructed for testing the explosibility of coal dusts under various conditions. One of these, in which the greater part of the systematic work will be carried out, is 4 feet in diameter and 1000 feet long. The other, which will be used mainly for demonstration explosions, is 7½ feet in diameter and 390 feet long. They are connected to fans arranged for creating a current of air in them in either direction.

The 4-foot gallery is equipped with instrument cabins every 100 feet, containing apparatus for measuring the pressures produced during the explosions and the speeds of the flames. These instruments are controlled from a distance at the observation station. Two special sections have been included in this gallery for investigating the effect of openings in the gallery (corresponding to the branches off an underground road) on the development of a coal-dust explosion.

Research on Firedamp Explosions.—The 7½-foot gallery is also used for the study of firedamp explosions. One of the principal series of experiments now in progress is to determine the distance to which the flame of an explosion can be projected along a roadway beyond the area originally occupied by the explosive mixture.

There is another gallery, one foot in diameter and 300 feet long, in use for studying the effect of restrictions in the path of the flame on its speed.

Research on Coal-mining Explosives.—The buildings for this work include (*a*) a research laboratory and gun-room in which photographic methods are used to investigate the flame and the pressure waves sent out by an explosive when it is fired, and (*b*) an explosion gallery and observation station where the igniting power of explosives under different conditions of detonation is tested directly by firing them into explosive mixtures of firedamp and air.

Research on Gob Fires.—Some coalfields suffer from fires which break out in the gob or goaf, the part of the mine where the coal has been worked. The building in which the study of gob fires is being made consists of a central chamber, 30 feet square and 8 feet high, simulating a goaf, with an air passage, approximately 6 feet wide by 7 feet high, circumscribing it. The main object of the research in progress is to determine the limiting conditions necessary for the production and ignition of explosive gas mixtures from a fire behind a stopping, and to study methods of sealing off a fire so as to avoid these conditions. Records of the temperature, and samples of the atmosphere at different points within the sealed-off area, can be taken periodically.

University and Educational Intelligence.

CAMBRIDGE.—Mr. Roger Fry, Sir John Marshall, and Prof. A. V. Hill have been elected honorary fellows of King's College. The Council has proposed to the University that the degree of LL.D., *honoris causa*, be conferred upon the Duke of Northumberland, Sir Archibald Denny, Sir Eustace Tennyson-D'Eyncourt, and Sir Charles Oman in connexion with meetings to be held at Cambridge this summer of the Institution of Naval Architects and of the Royal Archæological Institute. It is also proposed that the degree of M.A., *honoris causa*, be conferred upon Lieut.-Col. J. E. Craster, late R.E. Sir Humphry Rolleston has been appointed to represent the University at the coming Imperial Social Hygiene Congress.

Mr. A. S. Besicovitch, of the University of Leningrad, has been appointed lecturer in mathematics. Mr. H. W. Florey, Gonville and Caius College, has been appointed to the Huddersfield lecturership in special pathology. Dr. C. M. Yonge has been nominated to use the University Table at the zoological station at Naples for six months.

The annual report of the Solar Physics Observatory gives an account of the preparations and programme of Prof. Newall's expedition to Aal in Norway for the total eclipse of June 29.

Mr. R. V. Sayce has been appointed lecturer in material culture and physical anthropology. Dr. J. Chadwick, Gonville and Caius College, has been re-appointed lecturer in physics and assistant director of radio-active research.

F. W. Shotton, Sidney Sussex College, has been elected to the Harkness Scholarship in geology. E. J. H. Corner, Sidney Sussex College, and A. L. Bennett, Christ's College, have been awarded the Frank Smart prizes in botany and zoology respectively. The Tyson medal, in astronomy, has been awarded to C. S. M'Leod, Emmanuel College, and the Mayhew Prize in applied mathematics to J. Hargreaves, Clare College. The Rex Moir Prize in engineering and the Ricardo Prize in thermodynamics have been awarded to J. N. Goodier, Downing College. The John Bernard Seely prize in aeronautics has been awarded to C. E. Maitland, Peterhouse.

A grant has been made by the Balfour Managers to E. B. Worthington, Gonville and Caius College, for researches on the plankton of the Victoria Nyanza.

EDINBURGH.—At the meeting of the University Court on Monday, June 13, it was intimated that the Highland and Agricultural Society had resolved to make a grant of £1000 towards the endowment of the Department of Research in Animal Breeding.

The Court decided to make an annual contribution of £50 to the newly established British Institute in Paris.

NEWCASTLE.—The Council of Armstrong College has made the following appointments: Mr. Clement Heigham to be professor of agriculture, in succession to the late Prof. D. A. Gilchrist; Dr. J. W. Heslop Harrison to be professor of botany in succession to Prof. J. W. Bews, resigned; Mr. James Holmes to be lecturer in geography (a new appointment).

Mr. Heigham was educated at Wellington College and Caius College, Cambridge. He was for some time director of studies in agriculture at Caius College, Cambridge, and during 1923 and 1924 was director of the Norfolk Agricultural Station. Since 1925 he has been farm director at the Ministry of Agriculture's Experimental Station at Rothamsted.

Dr. Harrison is an old student of Armstrong College. He was at one time head of the science department at Middlesborough High School, and since 1920 has been lecturer in zoology in Armstrong College. In 1926 he was given the honorary title of reader in genetics. His researches on genetics, particularly on the question of the transmissibility of acquired characters, have made him widely known.

Mr. Holmes is a graduate of the University of Glasgow, and for the last four years has been senior assistant in the Department of Geography there.

OXFORD.—The great utility of the private laboratories belonging to Balliol, Trinity, Jesus, Queen's, and Christ Church has been recognised by the University in a recent decree authorising the payment of money grants to these laboratories which are to be equal to the normal laboratory fees paid by students working therein. It has long been recognised that Colleges which have scientific laboratories of their own have a very great advantage over those which are not so provided.

The preamble to a statute providing that there shall be an Aldrichian praelector in chemistry to be held by one of the University demonstrators has been approved.

ON June 7, in the presence of a great gathering representative of the west of England, and amid memorable scenes of enthusiasm, the Prince of Wales, president of the University College of the South-West of England, laid the foundation-stone of the new arts and administrative building of the College. The ceremony was of a peculiarly picturesque character and was enhanced by the magnificence of the exceptionally beautiful site which, known formerly as the Streatham Estate, forms one of the beauty spots of the south-west. The deputy-president of the College, Sir Henry Lopes, in welcoming the Prince, outlined the history of the rapid growth of the College, and explained that the increasing number of students and the rising standard and volume of academic work has impelled the College to find fresh quarters, more suited to the expanding needs. He stated that the appeal for a building and endowment fund, launched a few months ago, is evoking from month to month an increasing response. The greater part of the first £100,000 required has already been subscribed, and the lists show that all classes are contributing to the fund. The Prince in his reply congratulated the College on the support which the plans of expansion has evoked throughout the whole area. A people's university, created by the wishes and efforts of all classes, deserves the best that can be provided both as regards building and teaching, and he expressed the hope that the building would be a worthy monument to the hopes and ambitions of the people. His unexpected announcement that Lord Glanely is giving £25,000 to the appeal fund was received with enthusiasm.

Calendar of Discovery and Invention.

June 26, 1794.—The balloon was invented by the French, and the French were the first to use balloons in warfare. In 1793 a company of military aeronauts was formed, Jean Marie Joseph Coutelle (1748–1835) was made captain, and at the battle of Fleurus, June 26, 1794, he made observations from a balloon which it is said contributed to the success of the French. Coutelle and his company accompanied Bonaparte to Egypt, but their whole equipment was destroyed in the burning of *l'Orient* at Aboukir.

June 27, 1889.—The statue of Leverrier at the Paris Observatory was inaugurated on June 27, 1889. In his discourse Tisserand said: "The celestial world gets larger every day. . . . Yet our curiosity is inexhaustible; and however splendid may be the heaven which we are permitted to contemplate, we want to attain to greater knowledge still. We strive to realise what it was like in the most distant past, and what it will become in the most distant future. In this way—so it seems to us—our mind takes its revenge upon the shortness of our span of life and the frailty of our existence."

June 28, 1903.—It was at a meeting held at the Academy of Sciences, Munich, on June 28, 1903, that the Deutsches Museum von Meisterwerken der Naturwissenschaft und Technik was founded. Its inception and development owe much to the acumen and energy of Dr. Oskar von Miller, and its purpose is to represent physical science and its application to industry from the earliest times to the present day.

June 30, 1820.—Among the numerous papers contributed to the Linnean Society by Robert Brown was that read on June 30, 1820, on Rafflesia, the largest known flower.

June 30, 1866.—For centuries a barrier to human intercourse, the Atlantic is now crossed by steamships, submarine cables, aircraft, and radio signals. The first submarine cable, laid in 1858, failed after being in use a month, while the second, laid in 1865, was damaged in the laying. On June 30, 1866, however, the *Great Eastern* left the Medway with 3000 miles of new cable. The shore end was spliced on July 13, and on July 27 the ship steamed into Heart's Content, Newfoundland. No one contributed more to the final success of the project than Prof. William Thomson, afterwards Lord Kelvin, who for his share was raised to the knighthood.

July 1, 1858.—On July 1, 1858, Lyell and Hooker communicated to the Linnean Society papers which they described as relating to the same subject, namely, "The Laws which affect the Production of Varieties, Races, and Species," and as containing the results of the investigation of two indefatigable naturalists, Mr. Charles Darwin and Mr. Alfred Wallace, who "independently and unknown to one another, conceived the same very ingenious theory to account for the appearance and perpetuation of varieties and of specific forms on our planet. . . ." Of his own share Wallace said, "The one great result which I claim for my paper of 1858 is that it compelled Darwin to write and publish his 'Origin of Species' without further delay."

July 2, 1919.—The only aircraft which has flown to and fro across the Atlantic was the airship R34. With a crew of 26 she left East Fortune, near Edinburgh, on July 2, 1919, and reached New York in 4½ days. Her return was made in 3 days 3 hours. She was 645 feet long and 79 feet in diameter, contained nearly 2,000,000 cubic feet of gas, and was driven by five Sunbeam engines of 285 H.P. each. A year or two later she was damaged and then dismantled.

E. C. S.

Societies and Academies.

LONDON.

Royal Society, June 16.—**F. W. Aston**: A new mass-spectrograph and the whole-number rule (Bakerian Lecture). By means of the first mass-spectrograph, built in 1919, the masses of all atoms, with the exception of hydrogen, were shown to be whole numbers on the oxygen scale, to one or two parts in 1000. In order to measure their divergence a more powerful instrument was necessary. This has been made, with a resolving power of 1 in 600, more than sufficient to separate the mass lines of the isotopes of any known element, and with an accuracy of measurement as high as 1 in 10,000. By means of this instrument the isotopic constitution of mercury has been decided, new isotopes discovered in sulphur and tin, and the two doubtful isotopes of xenon confirmed. 51 types of atom contained in 18 different elements, ranging from hydrogen to mercury, have been examined. Their masses and packing fractions, *i.e.* their percentage divergence from the whole numbers expressed in parts per 10,000, are tabulated on the oxygen scale; *e.g.*, the atom of phosphorus of mass number 31 has a packing fraction $-5 \cdot 6 \pm 1 \cdot 5$ and a mass $30 \cdot 9825$. The relations of tin and xenon have been re-examined and found not to show the striking abnormality previously suggested. The values for Li^6 and Li^7 are obtained by a recalculation of Costa's results. When the packing fractions of the atoms are plotted against their mass numbers, for all atoms above mass number 20 these lie roughly on a single curve. From mercury, packing fraction $+0 \cdot 8$, the curve descends to -9 in the region of bromine. It then ascends, and in the case of atoms of odd atomic number continues to do so, in a roughly hyperbolic manner, right up to hydrogen $+77 \cdot 8$. The light atoms of even atomic number have packing fractions well below this curve, and approximate to a branch rising much less steeply to helium $+5 \cdot 4$. This suggests that the light atoms of odd atomic number have a common loosely packed, and therefore heavy, outside structure, which is not present in the denser and more stable nuclei of helium, carbon, and oxygen.

Linnean Society, May 12.—**James Groves**: Charophyta from Madagascar. Early in 1924, Mr. T. B. Blow made an extensive collection of Charophyta from Madagascar. Seven species of Chara were collected, all belonging to known and fairly distinct types. The representatives of the more intricate genus Nitella have proved difficult to discriminate. The new species described are probably mostly endemic to the island. None of the smaller genera is represented.—**T. B. Blow**: Observations on the alleged larvicidal qualities of Charophyta. Species of Charophyta were cultivated in large glass jars and mosquito larvæ were introduced; the effect of the glucoside from dried *Chara zeylanica* was also tried. In every case the larvæ enjoyed a vigorous life, and a large percentage attained to the winged condition.—**T. A. Sprague** and **V. S. Summerhayes**: The geographical distribution of some Santalaceæ. An investigation into the taxonomic status of the Australasian genus commonly known as Fusanus "R. Br." (non Murr.) led to its being divided into two genera—Eucarya T. L. Mitch. (Australia) and Mida A. Cunn. (New Zealand). It was then discovered that the now extinct *Santalum fernandezianum* F. Phil. (Juan Fernandez) should be transferred to the genus Mida. The distribution of Mida is of exceptional interest, one species occurring in New Zealand (North Island) and the other in Juan Fernandez. If it is monophyletic, the distribution may be interpreted as an extreme example of the well-known New Zealand-Chile (or South America) type, which is generally explained as the result of northward migration from the Antarctic continent. Possibly Mida had a diphyletic origin from Santalum, the ancestors of the New Zealand species having migrated from Australia and those of the Juan Fernandez species from Hawaii. The geographical distribution of *Santalum album* affords a problem of a different nature. *S. album* is known only from (1) southern India and (2) the eastern part of the Malay Archipelago, from eastern Java to Timor. This discontinuity may conceivably be due to extirpation by disease in the intervening area. A second hypothesis—that the species was introduced into India from eastern Malaya—is brought forward by Mr. C. E. C. Fischer.

CAMBRIDGE.

Philosophical Society, May 2.—**E. G. Dymond**: Excitation by high velocity electrons. With the velocity of the exciting electrons ranging from 100 volts to 1800 volts, the lines of the par- and ortho-helium series are reduced in intensity with increasing velocity, in roughly the same manner, and the intensities of the two series are of the same order of magnitude. This is in complete disagreement with work on the efficiency of excitation of the two series, made by an electron impact method. Excitation by fast electrons seems to proceed in two stages, the first being the excitation of the atom to any of a continuous series of states, and the second, the falling back into one of the normal series with emission of continuous radiation. The electron may lose any amount of energy greater than the lowest excitation energy. The process is similar to that put forward by Kramers and Heisenberg to explain the scattering of light.—**A. Caress**: Synthesis of ammonia by electrons.—**P. A. Taylor**: The light intensity of the calcium chromosphere. Prof. Milne's theory of the equilibrium of the calcium chromosphere is modified to take account of the curvature of the sun and the proper inverse square law of gravity. A method is developed for the calculation of the intensity of H and K radiation as observed in a telescope pointed near the limb of the sun in terms of the height above the limb of the point towards which the telescope is directed. Comparison of the calculated intensities with eclipse observations indicates that the co-efficient of partial support is probably of order of magnitude 10^{-4}.—**F. H. Constable**: On the effect of the addition of successive small quantities of poisonous substances on the velocity of catalytic gas reactions in closed vessels. A homogeneous distribution of centres of activity is more sensitive to the initial small quantities of poison than to the increments following. The experimental results of Pease and Stewart are used to show that there is a considerable change in the mean life of the carbon monoxide molecule on the most active, and least active, centres in the hydrogenation of ethylene by a reduced copper catalyst, showing that a distribution of centres does exist in this case, and that once the most active centres are poisoned the catalyst behaves as if it were homogeneous.—**H. Jeffreys**: Wave propagation in strings with continuous and concentrated loads. The nature of wave-propagation in a light string loaded with equal particles at regular intervals is discussed. There is no phenomenon similar to conduction of heat, but only dispersion. It appears probable, however, that irregularity of structure, if any, would introduce conduction.—**S. Goldstein**: On Mathieu functions.—**M. E. Grimshaw**: A case of distinction between Fourier integrals and Fourier series.

DUBLIN.

Royal Dublin Society, May 24.—Report of the Irish Radium Committee for the year 1926. Details are given of the treatment of more than two hundred cases with radium emanation supplied by the committee during the year.—**P. O'Connor**: A universal growth inhibiter in living tissue. The fluids of each species of plant or animal contain a simple diffusible substance of a specific character which is toxic to the protoplasm of all other species. This substance is not destroyed by boiling.—**W. H. Fordham**: The Eotvös torsion balance and vertical magnetometer.

EDINBURGH.

Royal Society, June 6.—**Ethel D. Currie**: Jurassic and Eocene Echinoidea from Somaliland. The collection, which belongs to the British Museum, comprises 14 Jurassic and 18 Eocene species. The Jurassic specimens, which are apparently all Bathonian, are from Bihendula and Ida Kabeitah in north central Somaliland and Biyo Dader in western Somaliland. New species of Acrosalenia and Echinodiadema are described and also a new genus, Farquharsonia, which has certain resemblances to Archæodiadema, Hemipedina, and Orthopsis. The fauna is European in affinities and implies a connexion between the Somaliland sea and the European sea of that time. The Eocene echinoids, collected in north central and eastern Somaliland, are from a lower cherty limestone and an upper white chalky limestone. The 11 species from the cherty limestone include a new species of Pericosmus, and are Lower Eocene. The 7 species from the upper white limestone, which include a new Linthia and a new Opissaster, are Middle Eocene. The author correlates the lower cherty and upper chalky limestone with the Auradli and Allahkajid limestones of Somaliland, thus reversing the supposed order of these two limestones.—**A. Calder**: A case of partial sex-transformation in cattle. A cow, following cystic degeneration of both ovaries, assumed the secondary sexual characteristics of the male.—**W. O. Kermack** and **W. T. H. Williamson**: The stability of suspensions (ii.). The rate of sedimentation of kaolin suspensions containing colloidal silicon dioxide. When kaolin suspensions contain a small quantity of colloidal silicon dioxide, the normal effect is one of weak protection, but under certain conditions an abnormally rapid rate of sedimentation occurs owing to the precipitation of a film of insoluble material over the surface of the particles. Under other conditions the abnormal rate of sedimentation, due to the formation of a film of this kind in the absence of silicon dioxide, disappears in its presence.—**Amy M. Fleming**: The peripheral innervation of the uterus. The work is a study of the part played in directing the activities of the uterus by the nerve structures which lie outside the central nervous system. It involved an anatomical study of the distribution of these nerve structures in lower animals and a physiological and pharmacological investigation of their mode of action. No evidence was obtained that the ganglia lying beside the cervix have any direct action, and the interaction of antagonistic drugs, while indicating the evidence of an intra-uterine control, failed to afford clear evidence of separate augmentory and inhibitory mechanisms.—**W. L. Ferrar**: On the consistency of cardinal function interpolation. A function $f(x)$ is obtained by interpolating from a set of values at $x=n$. The values $f(n-\lambda)$ are used to build up a new interpolation function $\phi(x)$. Under appropriate conditions $\phi(x)=f(x)$. The work is related to Titchmarsh's series inversion formulæ.—**W. H. Lang**: Contributions to the study of the Old Red Sandstone flora of Scotland. (vi.) On *Zosterophyllum Myretonianum*, Penh., and some other plant remains from the Carmyllie Beds of the Lower Old Red Sandstone; (vii.) On a specimen of Pseudosporochnus from the Stromness Beds. Zosterophyllum is characterised by peculiar branchings with a backwardly directed division, giving the appearance of an anastomosis of two parallel stems, and axes with radially arranged, stalked, reniform appendages. The appendages suggests that they may be rather flat sporangia, but no spores have been demonstrated. The plant had a thick cuticle and an epidermis, possibly with stomata. There is a central vascular strand, composed of tracheides with annular thickening bands, traversing the linear axes. Zosterophyllum is the most ancient vascular plant known from British rocks. The indications are that it can be placed in the Rhyniaceæ. Certain branched linear axes of a wholly different structure are described. Linear spore-masses are enclosed in some cases by an investment of this construction. A specimen recently added to the Stromness Museum provides a record of the occurrence of *Pseudosporochnus Krejčii*, known from the Middle Devonian of central Europe, in the Middle Old Red Sandstone of Scotland.—**Sir Thomas Muir**: The theory of orthogonants and latent roots from 1881 to 1918.

PARIS.

Academy of Sciences, May 16.—The president announced the deaths of Gustave André and of M. Tschermak.—**A. Lacroix** and **F. Blondel**: The existence in the south of Annam of a peperite resulting from the intrusion of a basalt into a diatomaceous sediment. There are two current views as to the origin of peperites, one (Julien) regarding them as formed by materials projected from basaltic volcanoes falling into lakes and cemented by calcite, the other (A. Michel-Levy) as resulting from the intrusion of a basaltic magma into limestone deposits. A detailed study of the Annam peperites is in agreement with the latter view.—**Maurice Hamy**: An empirical rule concerning the magnification of a telescope. A proof of the empirical rule that twice the aperture of the objective measured in millimetres gives the maximum useful magnification.—**A. Bigot**: The conditions of deposit of the upper Bathonian in the region of Caen.—Henry F. Osborn was elected *correspondant* for the section of mineralogy.—**L. Leau**: Method of recurrence or of complete induction applicable to space.—**A. Kovanko**: Suites of functions of class 1.—**Louis Breguet**: The maximum flying distances possible without descent and the transport capacity of aeroplanes of the future on long flights.—**Thadée Peczalski**: The action of salts on metals. The phenomena described explain various facts observed in the thermo-ionic emission of incandescent metals covered with a layer of salts, especially the known fragility after long heating and the increase of the electronic emission.—**F. Bedeau** and **J. de Mare**: The direct standardisation of a wavemeter as a function of the harmonics of a tuning-fork.—**St. Procopiu**: The influence of mechanical actions and of alternating currents on the discontinuities of the magnetisation of iron.—**D. Chalonge** and **M. Lambrey**: The structure of the ultra-violet absorption band of ozone.—**G. Colange**: The influence of temperature on photographic impressions. Researches on the optical properties of the upper atmosphere necessitated a knowledge of the influence of low temperatures on photographic plates. Experiments have been carried out on the law relating photographic density and temperature between 15° C. and $-60°$ C.

The results already obtained are sufficient to show the necessity of working at a constant temperature when making measurements of photographic photometry. A temperature variation of 5° C. introduces an error of $\frac{1}{15}$ in the comparison of the intensities of two sources of light.—**A. Grumbach**: Photovoltaic elements containing glycerol.—**Mlle. Suzanne Veil**: The magnetic behaviour of the modified hydroxides in the presence of hydrogen peroxide. From the observations given both from the magnetic and chemical point of view, treatment with warm water appears to paralyse the activity of nickel hydroxide. Experiments with ferric hydroxide lead to similar conclusions.—**J. Cournot, J. Bary,** and **E. Perot**: Coating aluminium, magnesium, light alloys, and ultralight alloys.—**J. B. Fournier** and **Fritsch-Lang**: The inalterability of commercial iron, copper, and zinc by liquid hydrogen sulphide. These metals are unchanged by prolonged immersion in liquid hydrogen sulphide and show no trace of corrosion or alteration.—**Pariselle** and **Laude**: The manganese hydrate carried down by alumina from an ammoniacal solution.—**Albert Kirrman**: The ethylenic organo-magnesium compounds.—**Ch. Courtot** and **G. Vignati**: Researches in the fluorene series.—**P. Blanchet**: A new layer carrying many fossils of the intra-Alpine Tithonic.—**J. MacLaughlin**: Measurements of the large ions at Paris. After discovering the large ions, Langevin put forward a theory concerning them of great importance in the physics of the earth. Two series of measurements of the large ions, carried out at Paris since 1925, confirm generally the views of Langevin. The present paper gives some of the first results of these measurements.—**Malmgren** and **Běhounek**: Measurements of the electrical conductivity of the atmosphere in the region of the North Pole. An account of experiments carried out during the voyage of the dirigible *Norge* from Kingsbay (Spitsbergen) to Teller (Alaska) in the course of the Amundsen-Ellsworth-Nobile polar expedition.—**E. Chemin**: The development of the spores and the parasitism of *Harveyella mirabilis*.—**A. Guilliermond**: The cytology and sexuality of *Spermophthora Gossypii*.—**St. Karasiewicz**: The influence of sodium carbonate and calcium chloride on the acidity of the juice of *Zea Mais*.—**L. Maume** and **J. Dulac**: The variation of antitoxic power as a function of ionisation.—**René Souèges**: The embryogeny of the Leguminoseæ. The last stages of the development of the embryo in *Trifolium minus*.—**Maurice Fontaine**: The influence of high pressures on the imbibition of the tissues.—**Ch. Oberling**: The existence of a neuro-muscular *housse* at the level of the glomerular arteries in man.—**E. Lacroix**: The texture of the shell of *Textularia sagittula*.—**P. Nottin**: The hydrolysis of starch by sulphuric acid. The experimental results given accord best with the view that sulphuric acid directly decomposes the amylaceous material into several products, glucose, maltose, other reducing substances and non-reducing glucides. The theory of successive reactions passing through a series of intermediate products is not confirmed.—**Marc Romieu**: A new histochemical reaction for the lecithines. The iodophil reaction. Lecithin gives a strong brown coloration when treated with a solution of iodine in potassium iodide. This resembles the brown colour produced by glycogen. It is probable that glycogen and lecithin may have been confused in earlier work.—**L. Meunier, P. Chambard,** and **H. Comte**: The pancreatic digestion of wool.—**E. Wollman** and **Achille Urbain**: Bacteriophagy and filtrable tumours. The fixation reaction in the Rous sarcoma.—**C. Levaditi** and **A. Klarenbeek**: The prophylaxy of the trypanosomiases by ingestion of moranyl (309 Fourneau or 205 Bayer). Moranyl administered to the rabbit *per os*, exercises a profound and lasting prophylactic action with regard to *Trypanosoma Nagana*. Comparative traits made with *T. gambiense* have furnished analogous results.

SYDNEY.

Linnean Society of New South Wales, Mar. 30.—**E. W. Ferguson**: Medical and veterinary entomology in Australia (Presidential address). Only certain groups of insects are concerned in the transmission of disease, insects whose life-history comes into close association with man or animals. These insects nearly all belong to the orders Diptera, Siphonaptera, Hemiptera, and Anoplura. (*a*) Diptera (Flies). The mosquitoes carry in Australia three distinct diseases, malaria, dengue fever, and filariasis. Tabanidae: no disease has been definitely traced to this family, but owing to their biting habits they are suspect. Muscidae: the common house-fly is responsible for the spread of typhoid, infantile diarrhœa, and dysentery. All flies are not enemies, for many are useful in destroying other insects. (*b*) Siphonaptera (Fleas). The Indian rat flea, an introduced species, is the vector of plague from rat to rat and from rat to man. The stickfast flea has been the cause of economic loss in poultry in Western Australia. (*c*) Hemiptera (Bugs). The common bed bug has been introduced but is not known to carry any disease in Australia, which is fortunately free from other blood-sucking species. (*d*) Anoplura (Lice). The three louse-borne infections of man do not now exist in Australia. Hymenoptera (bees, wasps, and ants) though not disease-carrying insects, are of interest from two points of view: (1) many will attack human beings, inflicting severe stings, and (2) several are parasitic on flies of economic importance.—**J. R. Malloch**: Notes on Australian Diptera. No. x. A new subgenus of Sapromyza is described, and also new species of Myodrosophila (1), Leucophenga (1), Drosophila (6), Gitonides (1), Desmometopa (1), Sapromyza (5), Homoneura (3), and Tapeigaster (1).—**Miss May M. Williams**: The anatomy of *Cheilanthes vellea*. *Cheilanthes vellea* is one of the few xerophytic ferns. The stem stele is a dictyostele. The petiolar stele, as it leaves the stem stele, is a simple adaxially curved anarch structure, but later three protoxylem groups appear. The pinnule has a reduced lacunar system, but a well-developed palisade. The stomata are confined to the lower surface of the pinnule and are protected by the inrolled margin of the pinnule together with a covering of hairs which grow out from the lower epidermis. The root is diarch. The apices of stem, leaf and root, and also the development of the sporangia, conform with those typical for leptosporangiate ferns. The sori are superficial and continuous, with a false indusium which is simply the inrolled margin of the pinnule. The number of spores does not exceed twenty.—**John Mitchell**: A new Deltopecten from the Illawarra district, N.S.W. The new species resembles *D. obliquatus*. It occurs in the Upper Marine beds, Permo-Carboniferous.—**John Mitchell**: The fossil Estheriæ of Australia. Part I. Only two species of Estheria have previously been recorded from Australia, namely, *E. Coghlani* Cox from Sydney, and *E. mangaliensis* Eth. Junr. from Ipswich. Eleven new species are described, and a new name is given to the species hitherto recorded as *E. mangaliensis*. These forms range back to the Upper Permian, when the species were of larger size than those obtained from the later Triassic formations.—**G. D. Osborne**: The geology of the country betwen Lamb's Valley and the Paterson River. The main portion of the area consists of a somewhat dissected plateau.—

C. Barnard: Note on a dicotyledonous fossil wood from Ulladulla, N.S.W. The specimen was obtained from the 'Silica' beds (Lower Tertiary) at Bannister Head, near Ulladulla, and is a piece of silicified wood. In structure the wood is that of a typical dicotyledon, and shows a very close agreement with that of the Saxifragaceæ, in which it is tentatively placed.—C. T. Musson and the late J. J. Fletcher: On a case of natural hybridism in the genus Grevillea (Proteaceæ). The flora of the higher portion of the Blue Mountains includes two species, *G. laurifolia* Sieb. and *G. acanthifolia* A.C., the plants of which differ markedly in many respects. Though belonging to different plant associations they frequently grow quite near each other under conditions that are often ideal for tempting birds to pass directly from the flowers of one species to those of the other. When these conditions prevail, certain rare and little known forms possessing intermediate characters are sometimes found.

Official Publications Received.

BRITISH.

British Museum (Natural History). Picture Postcards. Set E49: Mimicry in Insects, Series No. 1. 5 cards in colour. 1s. Set E50: Mimicry in Insects, Series No. 2. 5 cards in colour. 1s. (London: British Museum (Natural History).)

Experimental Researches and Reports published by the Department of Glass Technology, the University, Sheffield. Vol. 9, 1926. Pp. iii+334. (Sheffield.)

Transactions of the Royal Society of Edinburgh. Vol. 55, Part 2, No. 12: The Structure of the Disturbed Deposits of Møens Klint, Denmark. By Dr. George Slater. Pp. 289-302+1 plate. 2s. Vol. 55, Part 2, No. 13: The Disturbed Glacial Deposits in the neighbourhood of Lønstrup, near Hjørring, North Denmark. By Dr. George Slater. Pp. 303-305+2 plates. 1s. 6d. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

Journal of the Institute of Actuaries Students' Society. Vol. 2, No. 1. Pp. 72. (London: C. and E. Layton.) 2s.

The Opening of the Safety in Mines Research Station, Buxton, by the Viscount Chelmsford, 14th June 1927. Pp. 4+12 plates+32. (London: Safety in Mines Research Board.)

The Kent Incorporated Society for Promoting Experiments in Horticulture. Annual Report (Thirteenth Year) 1925. 2: Supplement. East Malling Research Station. Pp. 160+20 plates. (East Malling.) 5s. 6d.

Discovery Expedition. First Annual Report, 1926. Pp. 10+3 plates. (London: H.M. Stationery Office.) 1s. 6d. net.

Norman Lockyer Observatory. Director's Annual Report, April 1, 1926–March 31, 1927. Pp. 8. (Sidmouth.)

The Official Guide to Twickenham. Fourth edition. Issued by Authority of the Twickenham Corporation and the Twickenham and St. Margaret's Chamber of Commerce. Pp. 72. (London and Cheltenham: Ed. J. Burrow and Co., Ltd.)

Annual Report of the Calcutta School of Tropical Medicine, Institute of Hygiene and the Carmichael Hospital for Tropical Diseases, 1926; also a Brief History of the School and a Report for the Years 1920–1925. Pp. vi+152+27 plates. (Calcutta: Bengal Government Press.)

Memoirs of the Queensland Museum. Vol. 9, Part 1, April 26th. Pp. 126+17 plates. (Brisbane: Anthony James Cumming.)

Review of Agricultural Operations in India, 1925–26. By Dr. D. Clouston. Pp. v+152+10 plates. (Calcutta: Government of India Central Publications Branch.) 2.6 rupees; 4s. 3d.

Union of South Africa: Department of Agriculture. Bulletin No. 12: The Financial Side of Dairy Farming. By E. W. Sampson. Parts 1-5. Pp. 42. 6d. Bulletin No. 15: A Simple and Successful Septic Tank. By E. J. Van Meerten. Pp. 11. (Pretoria: Government Printing and Stationery Office.)

The Ross Institute and Hospital for Tropical Diseases (Incorporated), Putney Heath, London, S.W.15. Annual Report and Accounts for 1926. Pp. 36. (London.)

Malaria-Control in Malaya and Assam: a Visit of Inspection, 1926–27. By Sir Ronald Ross. Pp. 31. (London: Ross Institute and Hospital for Tropical Diseases.)

Empire Cotton Growing Corporation. Report of the Sixth Annual General Meeting. Pp. 18. (London.)

The Journal of the Institution of Electrical Engineers. Edited by P. F. Rowell. Vol. 65, No. 366, June. Pp. 553-652+xxx. (London: E. and F. N. Spon, Ltd.) 10s. 6d.

Quarterly Journal of the Royal Meteorological Society. Vol. 53, No. 222, April. Pp. 97-200. 7s. 6d. Supplement to Vol. 53: The Meteorology of Solar Eclipses. By E. W. Barlow. Pp. 24. 2s. 6d. (London: Edward Stanford, Ltd.)

British Museum (Natural History). Picture Postcards. Set F18: British Orchids, Series No. 3. 5 cards in colour. 1s. Set F19: British Orchids, Series No. 4. 5 cards in colour. 1s. Set F20: British Orchids, Series No. 5. 5 cards in colour. 1s. Set F21: British Orchids, Series No. 6. 5 cards in colour. 1s. (London: British Museum (Natural History).)

Journal of the Royal Microscopical Society. Series 3, Vol. 47, Part 2, June. Pp. 14+97-207. (London.) 10s. net.

Natural Science in Adult Education. Paper No. 8 of the Adult Education Committee. Pp. vi+54. (London: H.M. Stationery Office.) 6d. net.

Committee on Bird Sanctuaries, Royal Parks, England. Report for 1926. Pp. 15. (London: H.M. Office of Works.)

FOREIGN.

U.S. Department of Agriculture. Farmers' Bulletin No. 1521: Propagation of Game Birds. By W. L. McAtee. Pp. ii+57. (Washington, D.C.: Government Printing Office.) 10 cents.

Department of Commerce: U.S. Coast and Geodetic Survey. Serial No. 376: Geodetic Level and Rod. By D. L. Parkhurst. (Special Publication No. 129.) Pp. 12. (Washington, D.C.: Government Printing Office.)

Proceedings of the American Academy of Arts and Sciences. Vol. 62, No. 3: The Ants of the Canary Islands. By William Morton Wheeler. Pp. 93-120+8 plates. 75 cents. Vol. 62, No. 4: The Ants of Lord Howe Island and Norfolk Island. By William Morton Wheeler. Pp. 121-153. 50 cents. (Boston, Mass.)

Ministry of Public Works, Egypt: Physical Department. Meteorological Report for the year 1921. Pp. xv+162. (Cairo: Government Publications Office.) 40 P.T.

Statens Meteorologisk-Hydrografiska Anstalt. Årsbok, 8, 1926. ii: Nederbörden i Sverige. Pp. 152. (Stockholm.) 5 kr.

CATALOGUES.

Planetable Surveying Equipment. Pp. 12. (London: Cooke, Troughton and Sims, Ltd.)

Mathematical Models according to the Collection of Messrs. Werner and Treutlein. Pp. 20. (Manchester and London: G. Cussons, Ltd.)

Clinical Pathology and the Use of Stains: with Price List of Standard Microscopic Stains. Second Impression. Pp. 16. (London: The British Drug Houses, Ltd.)

Diary of Societies.

MONDAY, JUNE 27.

ROYAL IRISH ACADEMY, at 4.15.

TUESDAY, JUNE 28.

ROYAL DUBLIN SOCIETY, at 4.15.—J. Wilson: Lord Morton's Quagga-Horse Hybrid: Was it a Hybrid?—J. Reilly and G. Pyne: A Modified Micro-method for Molecular Weight Determination.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—Prof. V. Gordon Childe: The Ægean and the Danube Valley in the Second Millennium B.C.

WEDNESDAY, JUNE 29.

INSTITUTION OF MINING ENGINEERS (in Lecture Theatre of the North of England Institute of Mining and Mechanical Engineers, Newcastle-upon-Tyne), at 10.30 A.M.—G. Raw: Notes on the Overhead Koepe Winding Plant at the Murton Colliery of the South Hetton Coal Company, Ltd.—K. C. Appleyard: The Cleaning of Coal by Means of Pneumatic Separators, with Special Reference to the Sutton Steele and Steele Process.—W. D. Lloyd and Dr. J. N. Williamson: Experiments on the Reversal of Mine Ventilation.—Prof. H. Briggs, with an Appendix by Dr. J. Morrow: An Attempt at the Rationale of Faulting and Subsidence.—S. Walton-Brown: The Driving of Narrow Places.—J. I. Graham and A. Shaw: The Composition of Firedamp.—The following papers will be submitted for further discussion:—Miners' Nystagmus, Dr. F. Fergus; Miners' Nystagmus, Dr. J. S. Haldane and Dr. T. L. Llewellyn; The Construction of Flame Safety-lamps, Dr. R. V. Wheeler and D. W. Woodhead.

ROYAL SOCIETY OF ARTS (Annual General Meeting), at 4.

THURSDAY, JUNE 30.

ROYAL SOCIETY, at 4.30.—A. V. Hill, K. Furusawa, and J. L. Parkinson: The Dynamics of 'Sprint' Running.—A. V. Hill, K. Furusawa, and J. L. Parkinson: The Energy used in 'Sprint' Running.—T. S. P. Strangeways and Honor B. Fell: A Study of the Direct and Indirect Action of X-Rays upon the Tissues of the Embryonic Fowl (communicated by Sir William Hardy).—R. G. Canti and F. G. Spear: The Effect of Gamma Irradiation on Cell Division in Tissue Culture *in vitro* (communicated by Sir Frederick Andrewes).—And other papers.

RÖNTGEN SOCIETY (at Royal Society of Medicine), at 8.—Sir Humphry Rolleston, Bart.: Protection and Other Radiological Problems (Mackenzie Davidson Memorial Lecture).

INSTITUTION OF MINING ENGINEERS (in Lecture Theatre of the North of England Institute of Mining and Mechanical Engineers, Newcastle-upon-Tyne), at 9.45 A.M.

FRIDAY, JULY 1.

GEOLOGISTS' ASSOCIATION (at University College, Gower Street, W.C.1), at 7.30.—Sir John S. Flett: The Geology of the Edinburgh District (Lecture).

INSTITUTION OF MINING ENGINEERS (at Newcastle-upon-Tyne).

SATURDAY, JULY 2.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (North-Western District Meeting) (at Town Hall, St. Anne's on Sea), at 10.30 A.M.

PHYSIOLOGICAL SOCIETY (at Oxford).

ROYAL SOCIETY OF MEDICINE (Disease in Children Section) (Provincial Meeting at Royal Alexandra Hospital for Sick Children, Dyke Road, Brighton).

CONFERENCE.

JUNE 30 TO JULY 2.

NATIONAL ASSOCIATION FOR THE PREVENTION OF TUBERCULOSIS (at British Medical Association House, Tavistock Square, W.C.1).

Supplement to NATURE

No. 2992 MARCH 5, 1927

Our Bookshelf.

Human Evolution.

Éléments de sociologie : textes choisis et ordonnés. Par Prof. C. Bouglé et J. Raffault. (Publications du Centre de Documentation sociale.) Pp. viii + 506. (Paris : Félix Alcan, 1926.) 30 francs.

A COLLECTION of extracts such as MM. Bouglé and Raffault have compiled has its manifest uses as a source book and work of reference. This, however, has not been the primary or even the main object of its preparation, although the course of the Écoles Normales has been followed in the chief features of its framework. It is intended as a manifesto and reply to those who maintain the unsuitability of sociology as a subject of instruction on the ground that it is too young a science to have become sufficiently systematised and adequately provided with principles of general application to afford a suitable discipline. The compilers desire to refute this criticism by submitting to the reader what sociological writers have actually said, instead of entering into abstract argument. In England, perhaps, we have been fortunate; any controversy on this point being almost forgotten owing to an early acceptance of the evolutionary principle in its application to sociological data. Early exuberance, it is true, has had to be overcome, but the scientific attitude remains. This, however, does not affect the fact that for English readers, equally with French or those of any other tongue, this is a stimulating book in which the views of sociologists of to-day, yesterday, or long ago, on specific points arising out of a sociological scheme, may be found in their most characteristic form.

Grundriss der Anthropologie. Von Dr. M. W. Hauschild. Pp. viii + 235. (Berlin : Gebrüder Borntraeger, 1926.) 10·50 gold marks.

THE reviewer, after a perusal of this work, laid it down with the feeling that anthropology has suffered a profound loss by the death of its young author, Dr. Wolfgang Hauschild. In a preface written by his old teacher, Prof. Eugen Fischer, director of the Anthropological Institute of the University of Freiburg, we learn that Dr. Hauschild, after carrying out arduous investigations in Java during 1924, died from malaria on his way home, leaving behind him the manuscript of this work. One suspects that his text was intended to serve as a basis for a systematic course of lectures on the evolution and structure of human races, and that the condensation of his argument, although expressed in clear, simple German, would have been lightened and expanded by a free use of illustrative examples. It is plain, at least, that this rising anthropologist had addressed himself, not to the dilettante, but to the serious student of his subject.

The book is of particular interest to senior anthropologists, because it reveals the methods which the rising generation of investigators in Germany are applying to the problems of human evolution and of human heredity, and the ideals by which they are moved. Dr. Hauschild at once captures the English reader by ascribing to Darwin the just merit of being the sole author and initiator of the evolutionary movement which now moves thoughtful men in all parts of the world. He gives Mendel his due place—a very high one. The revolution in physical anthropology which Dr. Hauschild evidently anticipated was to arise from a fuller knowledge of the processes which regulate the development and growth of the human body. He has attempted to base his subject on physiological or biological principles, and for this reason has brought to bear on the human body the latest information gleaned from all branches of modern science. We see in this book a young author causing new sciences to leaven old knowledge, and all has been done in a logical, masterful way. We heartily commend this book to every one who wishes to get into touch with the best work now being done in the anthropological laboratories of Germany.

Prehistory.

Préhistoire de la Norvège. Par Haakon Shetelig. (Instituttet for Sammenlignende Kulturforskning. Serie A : Forelesninger, 5.) Pp. vi + 280 + 10 planches. (Oslo : H. Aschehoug and Co. ; London : Williams and Norgate, Ltd. ; Leipzig : Otto Harrassowitz ; Paris : Honoré Champion ; Cambridge, Mass. : Harvard University Press, 1926.) 7*s.* 6*d.*

DR. SHETELIG, the distinguished Norwegian archæologist, some four years ago published a review of the state of knowledge of prehistoric Norway at that date. Unfortunately for most readers it was in Norwegian, and the present volume, though written on a slightly different plan, as well as covering a more extended field, will be welcomed by those who wish to make themselves acquainted with the views of this authority on the archæology of his own country and its many problems. In his preface, Dr. Shetelig points out that the conditions, geographical and climatic, as well as the sparse population of early days, give the archæology of Norway a special character and, be it said, a peculiar significance. The salient problems throughout arise from the fact that the most marked characteristic of Norwegian culture is its receptivity and not its power of initiation. Norwegian culture, although individual, is a part of Scandinavian culture as a whole, and this in turn, although also distinctive, is an integral part of the general European culture. The task of the archæologist, therefore, is to analyse the data in such a way as to distinguish the foreign element and mark the modification by which it becomes essentially Norwegian.

The reader will follow with interest the method by which Dr. Shetelig has worked out this theme in tracing the development of Norwegian civilisation from the Maglemose period to the Viking age. In view of the use made of the early rock carvings in supporting the argument for the inheritance of palæolithic culture, as well as in the interests of the chapter on art, it is to be regretted that the book has not been more fully illustrated.

Frühschein der Kultur: Bilder aus Vorgeschichte und Urzeit. Von Prof. Dr. Johannes Ledroit. Pp. ix + 257. (Freiburg im Breisgau: Herder und Co. G.m.b.H., 1926.) 4·80 gold marks.

This well-planned little book aims at awakening the interest of the layman, and more especially of school-pupils, in prehistory by a lively and graphic presentation of the main facts. The outstanding features of each chief cultural period from Lower Palæolithic to Roman times are first briefly sketched. An imaginative description of some supposedly typical incidents from the epoch in question is added to fill in the details. We are introduced, for example, to a 'wandering artist' who winters in the cave of some reindeer-hunters and then passes on to another shelter after having adorned his hosts' abode with representations of bisons and other animals. We see the *Urgermanen* from the North Sea raiding the villages of the Michelsberg folk and witness the burial of a chief in a megalithic tomb. A description is given of a bronze age smithy and of the visit of a travelling dealer with copper and tin from England, who, with the aid of his 'slaves,' eventually carries off the smith's beautiful Nordic daughter.

Dr. Ledroit has carefully collected all the scattered scraps of archæological evidence that might help to complete a concrete picture of life in those remote times. There is less evidence of a mastery of the ethnographic data that might be invoked to supplement this inevitably fragmentary record, and a few mistakes have crept in. The bronze-worker may well have used the *cire perdue* process, but it is wrong to make him execute the spiral decoration on the finished casting; the mammoth is said to be a metre taller than existing elephants.

Birds.

(1) *L'Évolution de l'ornithologie.* Par Dr. M. Boubier. (Nouvelle Collection scientifique.) Pp. v + 308. (Paris: Félix Alcan, 1925.) 10 francs.

(2) *Birds and their Attributes.* By Dr. G. M. Allen. Pp. xiii + 338 + 34 plates. (London, Calcutta and Sydney: George G. Harrap and Co., Ltd., 1926.) 10*s*. 6*d*. net.

(3) *Les oiseaux: l'ornithologie et ses bases scientifiques.* Par Dr. M. Boubier. (Encyclopédie scientifique: Bibliothèque de zoologie.) Pp. iv + 305. (Paris: Gaston Doin et Cie., 1926.) 22 francs.

(4) *Fugle. 2: Lomfugle, Stormfugle, Vandhøns, Tranefugle og Vadefugle.* Af R. Hørring. (Danmarks Fauna, 30.) Pp. 332. (København: G. E. C. Gads Forlag, 1926.) n.p.

(1) In the steady stream of books about birds it is pleasant to find one which breaks new ground, as does Dr. Boubier's "L'Évolution de l'ornithologie." In a series of eight chapters he takes up particular aspects of ornithology and traces the gradual growth of knowledge in each branch of the science, marking the stages of development by appeal to the works of the masters. Thus he discusses the knowledge of the European avifauna, the results of explorations and voyages, the study of migration, of taxonomy, anatomy, and palæontology, and the development of systems of classification, and under each head the history is traced succinctly yet with sufficient detail to give a connected picture of progress. In so comprehensive a work omissions are bound to occur, and we note that no English writer on bird migration is mentioned later than Barrington (1772), and that although many and lesser bird-ringing schemes are referred to, the *British Birds* scheme which has been responsible for the marking of some 146,000 birds passes unnoticed.

(2) Dr. Allen's volume is excellent, although it belongs to a very familiar type—an introduction to a general survey of birds, their structure, habits, and human relations. It is outstanding because of the author's familiarity with recent literature, and his knack in selecting a telling example, as in the case of the narrow Atlantic belt which bars the distribution of two sets of terns (p. 155), or the Ceylon telegraph wire which bore an annual crop of mistletoe seedlings (p. 165), or the relation of the extent of a bird's migration to the shape of the egg it lays (p. 177). Of the illustrations the most remarkable are Mr. Bigelow's photographs of the V-shaped flight formations of swans and geese.

(3) In this other work of Dr. Boubier's we have a general treatise on birds, aiming less at the general reader than at the ornithologist who would add a scientific ground-work to his own observations. It is noteworthy for its conciseness, and for the care with which the comparative anatomy of birds is treated. A number of rough but very instructive diagrams illustrate the text.

(4) This, the second volume of a handbook of the birds of Denmark, deals with the divers, grebes, petrels, rails, and waders. The characters of the various species are indicated in key-tables, summer and winter plumages are described, a lengthy section gives an account of the migrations, habits, and status in Denmark of each species, and each description is accompanied by an excellent illustration in half-tone of the bird itself. J. R.

Systematic Zoology.

Handbuch der Zoologie: eine Naturgeschichte der Stämme des Tierreiches. Gegründet von Prof. Dr. Willy Kükenthal. Herausgegeben von Dr. Thilo Krumbach. Vierter Band: *Progoneata, Chilopoda, Insecta.* Erste Lieferung. Pp. 128. 13 gold marks. Zweite Lieferung. Pp. 129-240. n.p. Fünfter Band: *Solenogastres, Mollusca, Echinodermata, Tunicata.* Dritte Lieferung. Pp. 177-256. 8 gold marks. (Berlin und Leipzig: Walter de Gruyter und Co., 1926.)

THE fourth volume of Kükenthal's treatise opens with a short explanation of the extinction of the term Myriapoda, which has lost its strict systematic significance.

After a definition of the class Progoneata, the author, Dr. Carl Graf Attems, passes to the consideration of the constituent subclasses — Symphyla, Pauropoda, and Diplopoda—their anatomy, developmental stages, ecology, distribution, and classification. The sections on the Symphyla and Pauropoda are short—each about 9 pages—but that on the Diplopoda extends to more than 200 pages, and gives an admirably complete account of this subclass and its affinities. The classification is done in great detail—into orders and then into genera. The space devoted to systematics is disproportionately large, and we hope it may not result in restricting the pages available for the account of the Insecta in the later part of the volume. The parts are well illustrated, and at the end of the account of each class is a list of works of reference.

The first quarter of section 3 of vol. 5 contains the conclusion of the account—the development, ecology, and classification—of the Bivalvia. The rest of the part is devoted to the Cephalopoda, the description of which by Prof. J. Thiele is on the lines of the two preceding parts of the volume already noticed in NATURE. He gives a fair account of the anatomy, but finer structural details receive insufficient consideration, and reference to some of the newer work is lacking, for example, to the recent views on symbiotic organisms in relation to the luminous organs, to the details of formation and discharge of the remarkable spermatophores, and to the young stages of Spirula.

More illustrations would have been welcome in this section; particularly of important aspects such as the egg-cleavage and later stages of development, and the histology of the statocysts, eyes, and chromatophores.

Die Tierwelt der Nord- und Ostsee. Herausgegeben von G. Grimpe und E. Wagler. Lieferung 5. Teil 9.d$_1$: *Lamellibranchia*, von F. Haas; Teil 12.a$_1$: *Copelata*, von A. Bückmann. Pp. 96 + 20. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1926.) 8·80 gold marks.

THESE new parts of "Die Tierwelt der Nord- und Ostsee" maintain the high standard set by those already published. The greater part consists of a well-balanced account of the lamellibranchs by F. Haas; it is perhaps to be regretted that he uses the older classification based mainly on the teeth and hinge of the shell, rather than the newer classification by means of the gill structure, but he provides what will be of great service to the marine biologist, namely, good keys to the genera and species. There is an interesting account, illustrated with good tables, of the distribution of all the species and, in addition, a very brief summary of the present state of our knowledge regarding their structure and physiology is included.

The bionomics of the lamellibranchs—a subject of the utmost importance—are given due prominence by the author, both from the ecological and utilitarian points of view. Limnoria, however, is better considered as the precursor than as the enemy of Teredo, although the author admits that if it increased at the expense of Teredo "Teufel durch Beelzebub ausgetrieben würde."

The concluding pages of the parts before us are devoted to a short and very clearly illustrated account of the Copelata (Appendicularia), which has been contributed by A. Bückmann.

Les arachnides de France. Par Eugène Simon. Tome sixième. Deuxième partie: *Le synopsis général et le catalogue des espèces françaises de l'ordre des Araneæ (suite).* Œuvre posthume publiée par L. Berland et L. Fage. Pp. ii + 309-532. (Paris: L. Mulo, 1926.) 25 francs.

THIS part does not complete the supplement to "Les Arachnides de France." It deals with two sub-families of the Argiopidæ—the Theridiosomatinæ and Erigoninæ. The former contains the genus Theridiosoma, which is in some respects a link between the Theridiidæ and Argiopidæ and is represented in France and Great Britain by one species only. In the Erigoninæ thirteen new genera have been created without the addition of any new species, which seems somewhat drastic treatment. Some of the generic distinctions are slight and the generic characters will in some cases be more difficult to determine than the specific ones.

This part will be something of a disappointment to British arachnologists, who have been anxiously awaiting the remainder of this volume in the hope that the British and European classification of spiders might once and for all be unified. It is certainly a valuable contribution but falls short of our hopes.

Grundriss der allgemeinen Zoologie: für Studierende. Von Prof. Dr. Alfred Kühn. Zweite, verbesserte und vermehrte Auflage. Pp. viii+261. (Leipzig: Georg Thieme, 1926.) 13·20 gold marks.

In the first 84 pages the author gives an account, necessarily very condensed, of the various phyla. It is difficult to estimate whether some of the sections, *e.g.* one page of text for the sponges, about ten lines for the Ctenophora, six lines for the Bryozoa and for the Myriapoda respectively, will serve to convey to the student an adequate idea of the groups concerned. The author may depend largely on the laboratory instruction for the building up of the student's knowledge of structure, and the brief accounts may be intended chiefly for purposes of revision. The second part of the work (about 70 pages) deals with physiology—food and its transportation in the body, production of energy, respiration, excretion, animal heat, chemical relations between the organs, movement, reactions to stimuli. The final section of about 80 pages is devoted to embryology, heredity, and the origin of species. The figures are diagrammatic and clear; there is a list of works of reference and an adequate index.

Special Biological Studies.

Evolution im Lichte der Bastardierung betrachtet. Von J. P. Lotsy. Aus dem Englischen übersetzt von H. N. Kooiman. (Separat Abdruck aus *Genetica*, 7.) Pp. iii+365-470. (Haag: Martinus Nijhoff, 1926.) 4 guilders.

Early in 1925, Dr. J. P. Lotsy, at the invitation of the university colleges of New Zealand, delivered there three lectures on "Evolution considered in the Light of Hybridisation." These were afterwards published by Canterbury College, together with an introduction and an appendix by Dr. L. Cockayne, giving a list of more than 200 supposed wild hybrids in the New Zealand flora. These lectures have now been translated into German by Dr. H. N. Kooiman. The original edition was illustrated by eleven photographs of Mirabilis hybrids. These are replaced in the German edition by a coloured plate illustrating the remarkable range of fruit types obtained in the F_2 and F_3 generations from a cross between two varieties of pumpkin or squash.

So early as 1921, Dr. Cockayne had observed natural hybrids of Nothofagus and other genera growing wild in profusion, and he gives reasons why New Zealand is a particularly suitable place for their evolutionary study. Nevertheless, if natural species-hybrids are so abundant in the New Zealand flora, they must be of common occurrence elsewhere. In polymorphic genera, such as Rubus, Cratægus, Rosa, and Hieracium, the polymorphism is now, as the result particularly of cytological work, generally recognised to have arisen in connexion with crossing, and the number of such cases will no doubt be much extended.

Dr. Lotsy in his lectures has brought together many new and interesting data bearing on the subject. The statement of his views is less extreme than formerly, but he still leans very heavily upon the hybridisation hypothesis in places where it seems unnecessary. Although he admits that real mutations may take place, yet he invents terms such as 'sub-haploid' and 'super-haploid' hybridisation for processes with which geneticists have long been familiar as germinal changes, *e.g.* various processes by which new chromosome numbers arise. Why he assumes that such changes can only occur in Nature as a result of crossing it is difficult to see, since it is well known that some of them at least can be produced experimentally by changes in the conditions. Dr. Lotsy's view appears at its weakest in dealing with adaptations. Thus he suggests that the leafless Cacti and Euphorbiae may have arisen by the crossing of leafy succulent forms, the leafless offspring afterwards finding their way into the desert.

We think the author would strengthen his case if instead of trying to make hybridisation a universal evolutionary factor, he recognised it as merely one of the conditions under which the evolution of sexual organisms has taken place. He thinks evolution was made possible by sexuality, but he makes no attempt to explain the evolution of non-sexual organisms. R. R. G.

Der Formwechsel der Protistenkerne: eine vergleichend-morphologische Studie. Von Dr. Karl Bělař. (Sonderabdruck aus *Ergebnisse und Fortschritte der Zoologie*, Band 6.) Pp. 420. (Jena: Gustav Fischer, 1926.) 22 gold marks.

The author has made a thorough study not only of the literature of the Protozoan nucleus, but also of numerous specimens in various phases of nuclear activity. As he remarks, the newest developments of research in heredity have brought the nuclear changes in the Metazoa into the very centre of interest, but in the Protozoa genetical studies are only beginning, and much remains to be accomplished in this and in other connexions in the study of their nuclei. It is well, therefore, that the known facts have been brought together in such an accurate and orderly manner, for the limitations of our knowledge and the directions in which further investigations are required are more readily realised.

After a survey of the 'resting' nucleus, the author passes to the consideration of the various forms of mitosis and amitosis. He points out that amitotic nuclear division, formerly believed to be widespread in the Protozoa, appears normally to occur in the macronucleus of the Ciliata and in a few other cases only, and most of the latter are doubtful. The more interesting examples are carefully described.

The account of the behaviour of the nucleus preparatory to and during fertilisation includes a summary of present knowledge of the meiotic phase. A list is given of the number of chromosomes in nearly one hundred Protozoa, in some twenty of which the diploid and haploid numbers are stated. The nuclear changes which take place during the vegetative period are traced, the relationships between the nucleus and the cytoplasm and other components of the organism, *e.g.* flagella, cilia, trichocysts, are discussed and the spindle and centrosome are described. The last chapter is devoted to the more important views on the constitution of the protozoan nucleus, and includes a series of diagrammatic figures representing the different modes of division of the nucleus in the various groups of Protozoa.

In order not to burden the text with quotations from authors, Dr. Bělař has placed these, together with his remarks on them, in an appendix of some sixty pages. There is an extensive list of references and an index to the genera and species mentioned in the volume.

The accurate and critical treatment of this difficult subject has resulted in a volume which will be of great use to those who contemplate the investigation of the nucleus not only of the protozoa but also of the fungi and of the algæ. Special praise is due to the author and to the publisher for the abundance and excellence of the illustrations (many of them original) and for the detailed legend with which each is provided.

Die Pflanzenareale: Sammlung kartographischer Darstellungen von Verbreitungsbezirken der lebenden und fossilen Pflanzen-Familien, -Gattungen und -Arten. Unter Mitwirkung von Prof. Dr. Ludwig Diels und Prof. Dr. G. Samuelsson. Herausgegeben von Prof. Dr. E. Hannig und Prof. Dr. H. Winkler. 1 Reihe, Heft 1. Pp. iii + 14 + 10 Karten. Heft 2. Pp. 19-34 + 11-20 Karten. (Jena: Gustav Fischer, 1926.) 7.50 gold marks.

That the study of the distribution of plants is becoming of increasing importance in systematic work is being more and more realised. The controversial theories put forward by Willis (age and area) and by Wegener (continental drift), even if they have done nothing else, have been the means of stimulating a new interest in this branch of botany. A comprehensive work on the subject has now been commenced in Germany under the above title, edited by Drs. E. Hannig (Munster) and H. Winkler (Breslau), with the assistance of Drs. L. Diels (Berlin) and G. Samuelsson (Stockholm). The two parts issued are very large quarto, similar in appearance to the well-known "Vegetationsbilder" of Karsten and Schenck.

In Part 1 Prof. Engler gives an account of the distribution of Saxifraga, subsection Hirculoidea, to which are devoted three large maps. Other authors deal with the distribution of various genera and species of plants in a similar manner, amongst them *Genista anglica*.

In Part 2 Prof. H. Winkler shows the area occupied by the banana family, Musaceæ, in a wild state, and another map indicates graphically the range of the species of Musa under cultivation. Prof. Pax gives a short account of the genus Sapium and shows the distribution of the sections proposed by him in "Das Pflanzenreich." Other botanists deal with the range of various trees. In the case of the European and Mediterranean species of Abies, Dr. Mattfeld gives no less than two full pages of bibliographical references, in contrast to Prof. Pax's three references for Sapium. The work is somewhat unwieldy, resulting in considerable waste of space. For example, Karte 2 shows the distribution of three species of Saxifraga in a very small area of Central Asia on a circumpolar map about 10 in. × 14 in. A more judicious selection of sectional maps might easily have reduced the first part to at least half of its present proportions.

Polarised Light in Biology.

(1) ***Handbuch der biologischen Arbeitsmethoden.*** Herausgegeben von Prof. Dr. Emil Abderhalden. Lieferung 191. Abt. 2: ***Physikalische Methoden***, Teil 2, Heft 2. ***Die Verwendung der Polarisationsmikroskops für biologische Untersuchungen.*** Von August Köhler. Pp. 907-1108. (Berlin und Wien: Urban und Schwarzenberg, 1926.) 9.30 gold marks.

(2) ***Das Polarisationsmikroskop: seine Anwendung in der Kolloidforschung und in der Färberei.*** Von Hermann Ambronn und Albert Frey. (Kolloidforschung in Einzeldarstellungen, Band 5.) Pp. x + 195. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1926.) 13.50 gold marks.

These volumes represent recent additions to two series of 'handbooks' dealing with experimental methods in biology and the study of colloids respectively. The polarisation microscope, once finding its application exclusively in orthodox crystallography, is now being applied to the study of what Sir William Bragg so expressively terms "the imperfect crystallisation of common things."

The highly regular molecular arrangements often found in such objects as vegetable fibres, nerve filaments, cell walls, and so on, frequently leads to double refraction of large amount, which is measured without difficulty by the highly refined methods originally developed for mineralogical purposes.

(1) Köhler's discussion is arranged largely as a series of experiments designed to illustrate the main applications of the polarisation microscope, the determination of the directions of the axes of the index ellipse (the 'fast' and 'slow' directions), the use of the Sénarmont compensation systems, etc., all being thoroughly explained on physical principles with the minimum of mathematics. The optical features of konoscopic methods are also carefully treated, and a number of representative biological and colloidal applications are discussed. Unfortunately, the separate volumes of this series are not given an individual index, which somewhat detracts from the utility of each section by itself, but it is meant to be read in conjunction with Köhler's previously issued volumes on the microscope in the same series, and will be found clear and adequate.

(2) The volume by Ambronn and Frey will be found useful for readers more familiar with physics, and covers the ground rather more rapidly than the volume above. The latter half of the book is

devoted to the physical applications of the various methods; a valuable section deals with the results of O. Wiener's "Theorie des Mischkörpers," another with liquid anisotropism, and so on. Part 3 deals with the various optical methods employed to glean information as to the structure of dispersoids, and the directions of the particles. Celluloid and rubber are among the substances specifically discussed. The name of Richard Zsigmondy, the editor of the series, will be a guarantee of the reliability of this 'handbook,' which naturally explains much of the recent work of the authors.

Handbuch der biologischen Arbeitsmethoden. Herausgegeben von Prof. Dr. Emil Abderhalden. Lieferung 205, Abt. 2: *Physikalische Methoden,* Teil 2, Heft 4. *Polarimetrie,* von Heinrich Kessler; *Spektroskopische Methoden des Mediziners,* von Fritz Löwe; *Nephelometrie,* von Marie Anna Schirmann. Pp. 1345-1536. (Berlin und Wien: Urban und Schwarzenberg, 1926.) 8·70 gold marks.

FULL theoretical accounts of the subjects of polarimetry, spectroscopy, and nephelometry are given, together with descriptions of selected pieces of apparatus. The accounts are written from the point of view of the biologist rather than the physicist, especially the section dealing with spectroscopy, in which special reference is made to the blood pigments. The work should be consulted by all those interested in these particular branches of biological methods.

Modern Physics.

Die elektrische Leitfähigkeit der Atmosphäre und ihre Ursachen. Von Prof. Dr. Victor F. Hess. (Sammlung Vieweg, Heft 84-85.) Pp. viii + 174. (Braunschweig: Friedr. Vieweg und Sohn A.-G., 1926.) 8.50 gold marks.

As at once a professor of experimental physics and a field observer, Dr. V. F. Hess is specially fitted to write a general text-book on atmospheric electricity, and we learn from the preface that a work of this character by himself and his colleague at the University of Gratz, Prof. H. Benndorf, is in preparation. The present work deals with only part of the subject, and even within its ostensible limits it is not apparently regarded as altogether exhaustive. On one or two points the more extensive work in contemplation is referred to for further information, and in particular it will supplement the bibliography of the present work, though that is fairly extensive.

In the main the book treats of the electrical charges in the atmosphere and their origin. The theory of the Gerdien and Ebert apparatus is discussed, and the various methods of investigating the radioactive phenomena of the atmosphere. Various allied questions, *e.g.* the electricity of rain and thunderstorms, are only lightly touched on. As a pioneer investigator of the penetrating 'cosmic' radiation, Dr. Hess naturally gives special attention to that subject. He traces its development from the independent discovery by Gockel and C. T. R. Wilson of the ionisation in closed vessels, followed by the field work of McLennan, Wright, and others, then by the balloon observations by Gockel, Kolhörster, and himself, and finally by the recent work of Kolhörster and Millikan. He objects not unreasonably to the term 'Millikan rays' used by some Americans, but in his references to the conductivity of the upper atmosphere—a subject on which he supplies most up-to-date information—he makes free use of the term Kennelly-Heaviside layer, to which like exception can be taken.

The book so far as it goes may claim to replace the earlier German text-books by Gockel and by Mache and v. Schweidler, and within its sphere it is not inferior to the recent French works. It is interesting to note that in the name index at the end, the references to Elster and Geitel are only as numerous as those to Kolhörster, and only half as numerous as those to Prof. W. F. G. Swann. Dr. Hess does not, however, seem to notice that if the somewhat serious defect in the Ebert apparatus which he accepts as proved by Prof. Swann really exists, then much of the information which appears in the present book and elsewhere respecting negative ions must require correction. The view is taken that if satisfactory results are to be obtained in the open, the Ebert apparatus must be surrounded by a large mesh earth-connected wire screen. This seems a matter which deserves international consideration.

C. CHREE.

Müller-Pouillets Lehrbuch der Physik. Elfte Auflage. Herausgegeben von A. Eucken, O. Lummer, und E. Waetzmann. In fünf Bänden. (1) Band 2: *Lehre von der strahlenden Energie (Optik).* Erste Hälfte. Bearbeitet von O. Lummer. Pp. xviii + 928 + 7 Tafeln. 50 gold marks. (2) Band 3: *Wärmelehre.* Erste Hälfte: *Physikalische chemische und technische Thermodynamik (einschl. Wärmeleitung).* Bearbeitet von Arnold Eucken. Pp. xviii + 1185. 63 gold marks. (Braunschweig: Friedr. Vieweg und Sohn A.-G., 1926.)

THIS eleventh edition of one of the best-known German treatises on physics is the first that has appeared since the War. It shows conclusively that Germany is neither forced nor willing to abdicate her former leading position in the matter of exhaustive text-books.

(1) This volume may be regarded as Dr. Otto Lummer's last legacy to humanity. It was already in type when he died in July 1925, and has been finally brought out by A. Eucken and E. Waetzmann. It is significant of modern developments that the conception of an ether of space, which in the late pre-War years seemed to be losing ground, has to some extent been rehabilitated by the generalised theory of relativity, and particularly by the system worked out by Weyl in 1918. These theories regard the electromagnetic field and the gravitational field as two aspects of the 'metric' field which comprises all phenomena of time and space. The old contrast between

matter and ether is eliminated by the conception of matter as condensed and 'grained' energy in the gravi-electromagnetic ether.

The present volume covers the same ground as the corresponding volume of the tenth edition, except that spectrum analysis and phosphorescence are relegated to a further volume. The chapters on the eye and on optical instruments are entirely rewritten, and there are many additions to the chapter on interference and (especially) on prism combinations.

(2) The third volume, which deals with heat, has been subdivided, and while the book under notice deals with thermal phenomena in general, the next subdivision will deal exclusively with the kinetic theory.

It is literally true that the whole of the work has been rewritten. In this particular volume we find none of the old names. Pfaundler, Drucker, Wassmuth, and Hann are replaced by Eucken, Ebbecke, Jakob, Magnus, and others, and the bulk of the work has been done by Eucken, who celebrated his eightieth birthday this year!

It suffices to say that the new editors have carried out their great task in the spirit and tradition of the original work. No greater praise is necessary. "Müller-Pouillet" still stands unrivalled among 'elementary' text-books of physics which aim at being at the same time clear, accurate, and complete.

Anregung von Quantensprüngen durch Stösse. Von Prof. Dr. J. Franck und Dr. P. Jordan. (Struktur der Materie in Einzeldarstellungen, Band 3.) Pp. viii + 312. (Berlin: Julius Springer, 1926.) 19·50 gold marks.

This book is an up-to-date account of the work done in recent years on this interesting and fertile subject, a field of inquiry which is associated with the names of Franck, Hertz, Paschen, and Heisenberg in Germany, of Fowler and Horton in Great Britain, and of numerous contributors to the *Physical Review* in America. The first chapters describe and discuss the kinetics of slow-moving electrons in gases and vapours, the determination of critical potentials by the electron impact method and the relations between critical potentials and the spectral terms of atoms. Succeeding chapters discuss in detail the possibilities of excitation and of ionisation of atoms by electron impacts, and give a well-balanced account of collisions 'of the second kind.' In the seventh chapter an account is given of the critical potentials of molecules, especially those of hydrogen, nitrogen, oxygen, and the halogens. The concluding chapter deals briefly with the applications of the results obtained to chemical reactions.

From the first experimental work of Franck and Hertz to the latest theoretical speculations of Heisenberg is indeed a far cry. Perusal of this book will convince a reader to what extraordinary ramifications of physics the discovery of the electron and the application of quantum ideas to the structure of the atom have led. The subject is a difficult one; difficult both in its fundamental concepts and in the manner in which these are expressed, but one which every physicist must, and every physical chemist should, attempt to understand. It is a great boon, therefore, to have this up-to-date, fully documented compilation in the well-digested form which Prof. Franck and Dr. Jordan have given us. Both the experimental and theoretical sides of the work are adequately treated. To many this book will make a difficult subject reasonably clear and simple for the first time; it is a book which we whole-heartedly recommend to all students of physics.

Chemistry and Colour.

La chimie des matières colorantes organiques. Par Dr. Pierre Castan. (Encyclopédie scientifique: Bibliothèque de chimie.) Pp. 456. (Paris: Gaston Doin et Cie, 1926.) 30 francs.

The editor of the "Chemical Library," of which this book forms a unit, does not aim at producing dictionaries or books of reference, but books that will be *read* not by the chemist alone, but also by those who are interested in other branches of science, and by the general reader. The complete library will contain some eight volumes on general chemistry, twelve on inorganic chemistry, and eleven on organic chemistry, of which this volume is the second to appear.

The author is to be congratulated on having produced a most readable book, of which the opening chapter on the relation between the colour and constitution of organic compounds is a remarkably clear exposition of this important problem. In the succeeding eight chapters the chemistry of the different classes of synthetic dyestuffs is discussed, the final chapter being devoted to the naturally occurring colouring matters. Within the limited scope of the present volume there is no place for a section dealing with the chemistry of dyestuff intermediates; it is to be hoped that this serious omission will be rectified in some succeeding volume of the series.

Pyrosole: das kolloide Phänomen in der glühend Flüssigen Materie und seine Erstarrungszustände. Unter Berücksichtigung des latenten photographischen Bildes. Von Prof. Dr. Richard Lorenz und Prof. Dr. Wilhelm Eitel. (Kolloidforschung in Einzeldarstellungen, Band 4.) Pp. ix + 290 + 20 Tafeln. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1926.) 20 gold marks.

Colloidal solutions in which the continuous medium is solid at ordinary temperature are common in industrial processes, but owing to the experimental difficulties of investigating them, they have received less attention than solid-liquid systems. Prof. R. Lorenz is a pioneer in this field, and the monograph gives a summary of our knowledge of metal fogs in fused salts, coloured glasses, and the colloidal materials in minerals and slags. The consideration of similar solid colloidal solutions formed by the action of light leads naturally to an account of modern work on the photohalides and the latent photographic image. The excellent and numerous illustrations assist in making the book exceptionally interesting and useful.

Miscellany.

Tabulæ Biologicæ. Ed. W. Junk. Herausgegeben von C. Oppenheimer und L. Pincussen. Band 3: *Allgemeine Chemie, Konstanten chemischer Verbindungen, Chemie der Organe, Stoffwechsel, Grösse und Massen-Verhältnisse beim Menschen, Pharmakologie, Immunität.* Pp. vi + 829. (Berlin: W. Junk, 1926.) 63*s*.

THE contents of the third volume of "Tabulæ Biologicæ," which we have recently received, are somewhat inadequately indicated by the short titles of the different sections, given above. A vast amount of information of interest to physiologists and biochemists may be found here, which, in general, appears to be adequate and up-to-date. Thus the formulæ and chemical and physical constants of all the better-known substances on which physiologists and pharmacologists may require information are given in this volume; data are provided on the different natural and synthetic drugs used in medicine, including a most useful table of the innocuous, toxic, and lethal doses of a great variety of compounds. This volume also contains data on the chemistry of different organs and on metabolism; in the latter section may be found such information as the oxygen and sugar consumption of different tissues, the heat value and composition of different foodstuffs, and the physical constants of man himself at all ages. Whilst, as is perhaps inevitable in a work of this kind, equal stress is laid on data which may be of unequal value owing to the differences in the number of experiments on which the figures are based, and whilst in places the data themselves appear inadequate, as, for example, the table on the vitamin content of different foods, yet our thanks are due to the editor and his collaborators for providing biologists with such readily accessible information on a wide variety of subjects, culled from so many different sources.

Die Kriegsschauplätze 1914–1918 geologisch dargestellt. Herausgegeben von Prof. Dr. J. Wilser. In 14 Heften. Heft 14: *Die Isthmuswüste und Palästina.* Von Dr. Paul Range. Mit einem Beitrage von Dr. Walter Hoppe: *Paläontologie und Paläogeographie der Jura- und Kreideschichten der Isthmuswüste.* Pp. vi + 82. (Berlin: Gebrüder Borntraeger, 1926.) 11·40 gold marks.

DURING the War, Dr. P. Range was attached to the German-Turkish forces operating in Palestine to advise on the important matter of water-supply, and so had the opportunity of making a fairly detailed geological reconnaissance of the coastal plain of Palestine and the desert of northern Sinai (the Isthmus Desert) to the south. His chief observations have already been published in a number of papers in German periodicals, and include the discovery of important exposures of Jurassic rocks in the Maghara Range, in northern Sinai—a discovery in which, however, he had been anticipated by a Frenchman, M. Couyat-Barthoux, a year or two previously.

Since the War, a number of important papers on the geology of Palestine have appeared from other quarters also, and it is gratifying to note that the recent important discoveries of marine Trias and Jura in nearer Transjordania have been made by British geologists.

In including an account of these recent advances the present volume fulfils a useful purpose. It rather supplements than replaces the section on Palestine in Prof. M. Blanckenhorn's volume, "Syrien, Arabien, und Mesopotamien," published in 1914 in the "Handbuch der regionalen Geologie." Very little is said about the structural features of the region and their history, most of the book dealing purely with the stratigraphy. For a treatise of its size, too much space is filled by long lists of fossils, copied from recent palæontological papers on the area. Dr. W. F. Hume will be surprised to see himself referred to on p. 2 as "der inzwischen verstorbene Direktor der Geological Survey of Egypt."

Exercices de calcul différentiel et intégral. Par l'Abbé Potron. Premier volume: *Résumé théorique et énonces d'exercices.* Pp. xviii + 332. (Paris: J. Hermann, 1926.) 35 francs.

MOST of the standard French treatises on mathematical analysis expound the subject in a way that gives but little help to a student by supplying him with exercises to test his progress. The volume before us is welcome as a useful supplement to such treatises. It contains more than a thousand unworked examples on the differential and integral calculus, including their geometrical applications, and on differential equations. Many of the problems have been proposed as examination questions in the French universities, and show the tendency of mathematical thought there in recent years. Short and unexhaustive notes on the theoretical groundwork involved are added, but the book is in no sense a treatise on infinitesimal calculus. Although the range covered aims at being a wide one, there are omitted many branches of the subject with which every well-trained mathematical student should be familiar.

W. E. H. B.

L'Art musical dans des rapports avec la physique. Par Prof. Jean Becquerel. (Extrait du tome 2 du *Cours de Physique.*) Pp. iv + 79. (Paris: J. Hermann, 1926.) 6 francs.

JEAN BECQUEREL has the unique distinction of being the fourth in a direct line of distinguished physicists extending over more than a century, and occupying, moreover, the same official position in the National Museum, Paris. This portion of the author's "Cours de Physique" is separately reprinted in a handy form useful to both musicians and physicists. In the question of melodic scales it supports Helmholtz as against the strict Pythagoreans.

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Our Bookshelf.

Racial Evolution.

The Pedigree of the Human Race. By Prof. H. H. Wilder. Pp. xiv + 368. (London, Calcutta and Sydney: George G. Harrap and Co., Ltd., 1926.) 12*s.* 6*d.* net.

In this "Pedigree of the Human Race," the author writes as a professional zoologist "investigating the history of a single animal species which has become universally distributed." His style is one to which readers of books on early man on the eastern side of the Atlantic are little accustomed; it has much of the austerity of a text-book for the schools. There is great gain in clearness by this method of treatment, especially in the early stages, where the author deals far more fully than is usual with the data of palæontology.

As a zoologist the author is inclined to pay less attention to what he regards as the *amour propre* of man. He holds that the differentia of man are insufficient to place him in a separate family. He also puts forward a new system of ethnological classification based upon the view that racial evolution proceeds from an indifferentiated non-specialised stock towards differentiation and specialisation. This method, however, is not new in its conception, but rather in the detailed application in which it has here been worked out. The undifferentiated, least specialised race is, naturally, the Australian, the protomorph, followed by two metamorphic races, Caucasian-Mongolians and Ethiopians. Then come the archimorphs, proto-Caucasian, proto-Mongolian, and proto-Ethiopians. The classification is obviously of great interest, but in detail seems open to criticism. It is necessarily given in skeleton, and before criticising it, it would be desirable to know how the author has handled the data on which it is based. His treatment of the Malay, for example, does not seem entirely satisfactory. "The most singular coincidence in anthropological history" to which the author directs attention, by which Pithecanthropus was brought to light in the year of Haeckel's sixtieth birthday, 1894, he must abandon, no doubt with regret, as that discovery was made in 1891–92, as correctly given on a previous page.

The Formation of the Greek People. By Prof. A. Jardé. Translated by M. R. Dobie. (The History of Civilization Series.) Pp. xvi + 359. (London: Kegan Paul and Co., Ltd.; New York: Alfred A. Knopf, 1926.) 16*s.* net.

This volume of the "History of Civilization" Series is an attempt to explain the Greek 'miracle,' meaning, as Mr. Henri Berr says in his preface—not a miracle in the sense of Christian mysticism, but an object worthy of admiration, with an implication of contingency. M. Jardé has given his readers an analysis of the course of events in the various city States in their external relations *inter se* and with other peoples, of their political, social, and intellectual development, of Hellenic expansion and the development of Hellenic unity, which is little short of brilliant. Yet it is difficult to characterise the book as a whole, and gauge its success in achieving its object, for it is a paradox, both as a whole, as the author acknowledges, and also in its parts.

Both anthropologist and geographer may feel that notwithstanding M. Jardé's admirable account of geographical conditions and racial elements, in turning aside to find the answer to his problem in the efforts of man which "turn possibilities into realities," he has perhaps missed the subtler factors of the solution. If to find an explanation in tracing the historical course of events in each State up to the unification of Greece under Macedon be a paradox, it is even more paradoxical to regard the course of events as unconditioned excepting so far as causally connected in succession one to another, when once they have been set in train. After this comment—for it is scarcely a criticism—it is perhaps unnecessary to say that M. Jardé's contribution to the series is both interesting as an analysis of city State history and stimulating, if not provocative, as an exercise in historical method.

Primitive Culture in Italy. By Prof. H. J. Rose. Pp. ix + 253. (London: Methuen and Co., Ltd., 1926.) 7*s.* 6*d.* net.

Mr. Rose's companion volume to his "Primitive Culture in Greece," if introduced into schools, might well serve to eliminate much of the dreariness which teachers of the classics have too often succeeded in introducing into the study of Roman religion and social organisation. Postulating a primitive culture and religious belief in which *mana* is the predominant element—*mana*, Mr. Rose points out, is a conception to which *numen* is closely akin—he shows that in classical Italy religion—the gods, worship, and magic—the calendar, the conceptions attaching to priests and kings, and the organisation of the family and the clan, the ideas underlying the law relating to crimes and torts, property, etc., on analysis yield an element referable to certain primitive conceptions; in other words, that much in the observances of classical times is explicable only as survival from prehistoric times. Mr. Rose's treatment of religion is particularly illuminating, and his suggestion that the practical aim of ritual and observance was essentially occasional and intended to direct *mana* into profitable channels does offer a reasonably sound explanation of the Roman deities, which stand apart from the circle of deities obviously imported from outside.

Origins of Education among Primitive Peoples: a Comparative Study in Racial Development. By W. D. Hambly. Pp. xi + 432 + 79 plates. (London: Macmillan and Co., Ltd., 1926.) 25*s.* net.

Contrary to popular impression, little boy and girl savages do not live quite a care-free existence, even though they are often more spoiled by their parents than the child of civilisation. The medium of their education often disguises the fact that they are being educated. As with all animals, the early stages of education, largely but not entirely physical, are almost wholly carried on through the play activities—among the boys, mimic hunting, fighting, and care of cattle; among the girls, care of dolls, and simulations of women's work in the field and home. Sometimes instruction may be even more organised and the father will take the boys as his helpers, while the mother requires the assistance of the girls in her work, an appropriate task to be learned at each age. The subject of education among primitive peoples has not been adequately studied, and Mr. Hambly's book serves a useful purpose in gathering together the facts as they have been recorded by travellers and ethnographers. He has brought out very clearly not only the value of the instruction imparted in puberty and initiation ceremonies, but he also emphasises what is apt to be overlooked, namely, the importance of the environmental influence by which the ethical code of the community forcibly, if imperceptibly, impresses itself upon the individual.

Elementary Botany.

Elementary Botany: an Introduction to the Study of Plant Life. By Dr. W. Watson. Pp. viii + 368. (London: Edward Arnold and Co., 1926.) 6*s.* 6*d.*

The number of elementary botanical text-books published in England and America is now so large that it is perhaps not hypercritical to expect that any addition to their number should contribute originality either in substance or in treatment. The text-book before us departs from the conventional type chiefly in its omissions. Thus, although the reader will find the elaters of the liverwort described both as to their structure and function, the fibrous layer of the angiospermic anther receives but passing mention, and incidentally is erroneously figured. Similarly, though the reader will find details of the microscopic structure of the thallus of Xanthoria, he will not grasp those details of the stoma of the flowering plant upon which its action depends.

The description is simple and direct though at times a trifle colloquial, and not infrequently the phraseology does not sufficiently guard against the perpetuation of common errors. Such a statement, for example, as that "respiration is merely a method whereby oxygen can be supplied to the tissues in the working part of the body and the waste carbon dioxide taken away," will, despite the context, probably lead to grave misconceptions in the student's mind. Again, in the description of the tissue elements, in the explanation of Mendel's results, and elsewhere, there appears to be a lack of appropriate emphasis on essentials.

Suggestions for experimental work of a simple character are interspersed in the text, and the physiological and histological aspects are appropriately interwoven with the morphological treatment.

A Practical Introduction to the Study of Botany. (Specially intended for the Use of Indian Students.) By Sir J. Bretland Farmer and Dr. Haraprasad Chaudhuri. New edition. Pp. viii + 300. (Calcutta, Bombay and London: Longmans, Green and Co., Ltd., 1926.) 3 rupees.

It is some years since the original edition of this book appeared. Since then considerable advances in our knowledge have been made which are not adequately reflected in these pages. It is true that the trend of modern botanical progress is recognised by the inclusion of a chapter on ecology and one on evolution and heredity, but, to employ the jargon of the diplomatist, these amount to little more than 'gestures,' since ecology is disposed of in five pages chiefly devoted to an enumeration of Warming's habitat classes, whilst evolution and heredity furnish the subject matter of barely four pages, of which two deal with the familiar Mendelian segregation.

The chief modifications from the earlier edition concern the substitution where necessary of Indian for European types and appropriate modifications in the families considered. Several errors of the original edition remain uncorrected, as, for example, the figure of the vascular system of the dead-nettle, in which the four main bundles are shown in duplicate, and the figure of *Sonchus crispus* which appears as *Sonchus oleraceus*. We may note, too, the absence of ligules from Fig. 154 purporting to represent a longitudinal section of a Selaginella cone. There are also several irritating if minor misprints, and one cannot but regret that the occasion was not taken to revise the work completely and bring it up-to-date.

The Story of the Plants. By Grant Allen. (Hodder and Stoughton's People's Library.) New edition, fully revised and annotated, and with a Biography of the Author by Marcus Woodward. Pp. 200. (London: Hodder and Stoughton, Ltd., n.d.) 2*s.* 6*d.* net.

Grant Allen's "Story of the Plants" is a work which had a considerable vogue at a time when popular books on botanical subjects were comparatively few. In the present abridged edition, although the original text remains unchanged, except for deletions, the editor has wisely prefaced each chapter by a short introduction correcting some of the errors of which the author was guilty, and placing the text in relation to modern knowledge. There is, indeed, so much at the present day to modify, either in fact or inference, that the interest of the work is largely historical. Grant Allen took considerable licence as to his manner of expression, whilst some of his statements were not always too well based, but the merits of his writings must be judged by the available knowledge at the date of publication. The time has fortunately long since passed when accuracy of description was incompatible with popular appeal, a position which we owe in no small measure to the activity of natural history societies and the growing recognition that a real understanding of biology is an essential part of a liberal education. Many will therefore welcome the opportunity of becoming acquainted at small cost with a work which played a part in the popularisation of natural science some thirty years ago.

Plant Products.

Gum Arabic: with Special Reference to its Production in the Sudan. By H. S. Blunt. Pp. 47 + 22 plates. (London: Oxford University Press, 1926.) 10*s*. 6*d*. net.

The author, who is assistant conservator of forests to the Sudan Government, states in the preface that he has been persuaded to place on record some of his observations on gum arabic carried out during five years' work in one of the main gum-producing districts of southern Sudan. A perusal of the book gives the reader quite a vivid impression of the local conditions of collection and cultivation, as well as details as to markets, freight, royalties, water supply, etc., and as a more or less informal record of observations made on the spot it will be read with profit by those interested in the gum-arabic trade. The book cannot, however, be regarded as a serious contribution to the scientific aspects of the question. For example, the opening sentence of the section on chemical properties—“Gum may be regarded as a potassium and calcium salt of gummic or arabic acid of the general formula ($C_6H_{10}O_5$)”—scarcely inspires confidence. Reading on, one finds a detailed account of how to dissolve gum arabic in water for the purpose of determining its viscosity, but there is no indication as to how the measurement is made, and, moreover, the figures given to represent the viscosity appear to show that in five cases out of six the viscosity of a 20 per cent. aqueous solution is less than that of a 10 per cent. solution. Again, a paragraph on p. 43 states that “The author has seen and isolated a bacillus both from a solution made from branches of the tree and from the gum itself. In each case the bacterium seen was exactly the same. The organism appeared to be rod-shaped and was extremely mobile.” One is inclined to wonder what a bacteriologist would think of such an identification.

In view, however, of the fact that the author modestly states that he is cognisant of the incompleteness of his work, he would probably lay no claim to writing a scientific treatise, but that is all the more reason for either avoiding scientific aspects or else subjecting the manuscript to critical revision by experts. The numerous illustrations at the end of the book add greatly to the interest of the text, though, strange to say, they are but rarely referred to there.

Plant Products. By S. Hoare Collins and George Redington. (Industrial Chemistry Series.) Pp. xiii + 262. (London: Baillière, Tindall and Cox, 1926.) 10*s*. 6*d*. net.

This is the second edition of the first author's “Plant Products and Chemical Fertilisers”; the title has now been abbreviated, as the chapters dealing with artificial fertilisers have been slightly curtailed, the subject having been more fully treated in the companion volume, “Chemical Fertilisers.” The general arrangement of the book is much the same as before, but the third part has been extended somewhat to include a short account of the main factors operative in the process of photosynthesis, while the fourth part has been modified considerably by the inclusion of modern conceptions of the values of food materials.

Taken as a whole, the book will be found to be most readable and to contain a great variety of interesting information, but in many cases the treatment is distinctly scrappy, and it is to be regretted that some of the facts concerning pectins and mucilages have not been brought up-to-date. The indexing also is very poor; in one case the name Hokkaido of the Japanese University in that place is given as a reference to a paper on acid mineral soils by three authors of entirely different names. It is to be hoped also that the large number of misprints of names of authors, etc., will be corrected in any future edition.

Horticulture.

(1) *The Principles and Practice of Horticulture.* By A. S. Galt. (Text-Books on Agriculture.) Pp. viii + 240. (London: University Tutorial Press, Ltd., 1926.) 3*s*. 6*d*.

(2) *Fruit Growing.* By Prof. W. H. Chandler. Pp. xv + 777. (London, Bombay and Sydney: Constable and Co., Ltd., n.d.) 21*s*. net.

Horticulture is one of the most ancient industries, yet as a science it is a mere babe. Not a few who are engaged in the industry have yet to awake to the existence of the science. Here are two books which should speed up that awakening.

Though written by teachers well known in the horticultural spheres of England and the United States, these two books are in every other respect as different as, let us say, chicory from cherries. (1) Mr. Galt's book is quite in the traditional style (and English, not American, tradition at that), founded mainly on long-established practice, with all too few references to the results of recent research. Even these few are not always so accurate as might be wished; it is to be hoped that if a second edition is called for, the table on p. 194, vitally influencing as it should the practice of fruit-planters, may at least be corrected. Again and again one is pulled up short by question-begging statements, based sometimes on observation, often merely on long-cherished opinions. How often these traditional views and practices have had to go by the board is shown in the second of these books.

(2) Prof. Chandler has produced as comprehensive a review of agricultural and horticultural research, in their bearing on fruit-growing, as the most exacting reader could demand. His title, however, is somewhat misleading. Though fruit-growers as a body are far more alive and interested in research than they were twenty, or even ten, years ago, there are still very few in whose hands this book could be placed with some hope of its being adequately studied. That it is directed primarily towards those engaged in research is shown in the introduction, which plunges forthwith into a detailed discussion of the reliability of field experiments, the probable error, and other mathematical concepts used by up-to-date research workers, but meaningless to a very large proportion of practical fruit-growers.

Yet much of this book would be easily assimilable by the average fruit-grower if only he could be persuaded to give his mind to the study of it. The author is far from ignoring current practice, but shows wherever possible to what extent it is justified by the results of research; and he is not afraid to show how frequently the results obtained by different workers are contradictory. He even gives more or less satisfactory explanations of these contradictions, and is always careful to give the reader some indication of the probable reliability of each result. The book is concluded by an admirably arranged and most comprehensive bibliography.

Farm Management.

(1) *Farm Calculations and Accounts, including a Thorough Treatment of Agricultural Calculations and of the Business Transactions of the Farm.* By Dr. Arthur G. Ruston and C. Vivian Dawe. (Text-Books on Agriculture.) Pp. x + 222. 3*s*. 6*d*.

(2) *Farm Measurements: a Practical Treatment of Problems in Mensuration.* By Dr. Arthur G. Ruston and C. Vivian Dawe. (Text-Books on Agriculture.) Pp. x + 163. 2*s*. 6*d*.

(3) *Agricultural Surveying, including Mensuration, Road Construction and Drainage.* By John Malcolm. (Text-Books for Agricultural Students.) Pp. vii + 313. 5*s*. 6*d*.

(London: University Tutorial Press, Ltd., 1926.)

THE importance of accurate figure work in agriculture, as in costings accounts and measurements of various types, is reflected in the production of text-books specially adapted for the use of farmers and agricultural students.

(1) In "Farm Calculations and Accounts" the preliminary chapters are devoted to a simple exposition of the arithmetical rules, fully illustrated by examples drawn from ordinary farm life. These rules are then applied to such items as household and commercial accounts, valuation and purchase of manures, calculation of costings appertaining to crops, foodstuffs, and livestock. The value of graphs for the diagrammatic representation of facts is indicated, with examples of the various ways in which a graph can be projected. A specially useful feature is a short chapter on the writing of business letters, a matter in which much haziness prevails as to the correct order of procedure.

(2) In their other book referred to above, Dr. Ruston and Mr. Dawe deal with the methods used in obtaining lengths, areas, and volumes associated with farm practice, attention also being given to brickwork and building construction and to matters connected with water supply, work, and power. Measurement of standing timber, spreading of farmyard manure, and estimation of weight of roots per acre are among the special items dealt with in some detail.

(3) Mr. Malcolm's work covers a somewhat different field from the foregoing, in that it includes mensuration, road construction, and drainage. An excellent description is given of methods of field surveying, a point specially to be commended being the mention of many details the knowledge of which makes for smooth and accurate working. The use of the various instruments is well described, and the book should be valuable not only for surveying students connected with agriculture, but also for others.

Estate Accounts. By C. S. Orwin and H. W. Kersey. Pp. vi + 45. (Cambridge: At the University Press, 1926.) 3*s*. 6*d*. net.

THE object of estate accounting is to assist in management quite as much as to act as a check to expenditure, but very few books are available which describe desirable methods to be adopted. The present volume aims at presenting a system of estate book-keeping which entails the minimum of clerical labour, and provides the maximum amount of detailed and analysed information. The method suggested is very elastic, and is exemplified by a full year's working of one particular estate, showing all the necessary associated accounts, with the subsidiary books and records in the hands of subordinate workers.

A picture of the financial history of an estate is not easy to visualise from a consideration of the account books for several consecutive years, but it is clearly portrayed by means of graphical representation of the different accounts. Illustrations are given of graphs showing such items as rental, property tax and super tax, tithe rent charges and improvement rent charges, which demonstrate how useful such a method of delineation may be in the hands of estate agents and property owners. It indicates clearly the effect of changes of estate policy, of public policy, and of economic conditions on the fortunes of the estate.

Oil and Ore Deposits.

The Location of Mineral Fields: Modern Procedure in the Investigation of Mineral Areas and the Subsequent Verification of their Extent, etc. By M. H. Haddock. (Lockwood's Manuals.) Pp. vii + 295. (London: Crosby Lockwood and Son, 1926.) 9*s*. 6*d*. net.

THE outstanding merit of this book is that it co-ordinates much useful and practical information scattered through a number of other works. Dispensing with any introductory matter, the author commences to deal with certain geometrical properties of mineral deposits, as dip, strike, depth and thickness of strata, and the determination of these by calculation and by geometrical methods. Two chapters follow on contouring and the form of outcrop and mineral mapping practice. Under borehole surveying, both early and modern methods are discussed; the determination of the dip and strike of a seam by means of three boreholes is taken as a typical practical example and dealt with in all its possibilities. Faulting and folding is treated with the aid of many explanatory figures, and the determination of fault data by calculation is discussed.

The chapter on applied geophysics, a subject on which a separate book is long overdue, deals with the chief physical methods employed for the location of ore bodies, the instruments used, and some applications of these. This chapter is perhaps one of the best available summaries, in English, of the practical details and significance of geophysical methods. It is, however, difficult to see why Germany and Sweden should be persistently regarded as the only countries in which progress in geophysical methods of investigation and prospecting has been made since 1918; important research has been carried out in England, particularly with regard to the Eötvös torsion balance. Chapters on spherical trigonometry and astronomical methods in so far as they concern surveying, and on triangulation, are sound and replete with practical information. The correlation of surface and underground surveys occupies the last chapter.

This book does not concentrate on the theoretical aspects of the problems involved, but attacks each subject from the practical point of view; it is a thoroughly practical disquisition and should commend itself to mining students and others.

E. R. F.

The Geology of Oil, Oil-Shale and Coal. By Dr. Murray Stuart. Pp. ix + 104. (London: Mining Publications, Ltd., 1926.) 7*s*. 6*d*. net.

AN ambitious title, a few bold theories, some sweeping deductions based, perhaps, on slender evidence, the forging of a few weapons of attack for the oil geologist's armoury, one or two critical causeries: these constitute the chief features of this unorthodox little volume. Impressed by the fact that oil deposits "retain no fossil evidence of the origin of the oil" (?), the author is led to the conclusion that in such cases it has probably been deposited along with the sediment according to generally accepted principles of deposition; this, the first hypothesis. Turning next to coal, "each little layer . . . represents an individual sedimentary stratum." This implies that coal does not represent a state of carbonisation of vegetable matter *in situ*, but rather the consolidation of black mud directly transported by rivers from freshwater swamps and laid down normally with sedimentary détritus: thus the second theory, originally formulated by Jukes, resuscitated by the late Charles Lapworth in the course of a lecture in 1906, from which the author acknowledges inspiration in his preface.

Petroleum in dolomitised limestones *ipso facto* disposes of the theory of its sedimentary deposition in such cases; hence these special circumstances are examined and the conclusion reached that foraminifera with specific bacterial aid are the influential contributors, fossils of bottom-living forms being absent. A further hypothesis concerns Burma petroleum and suggests the silicified wood of Dipterocarpus as a possible mother-substance, a theory which has recently engaged the critical attention of L. Dudley Stamp. Thus we reach the author's 'six points' for the oil geologist, wherein attention is directed to dolomitised limestones, as above outlined, to foraminiferal or diatomaceous shales minus bottom-living fossils (diatoms have lately been discounted by American geologists as being fundamental in the mother-substance of the really classical example, the Monterey Shale of California), the lateral variation of coal seams through torbanite to oil-shale or into liquid petroleum (given suitable carbon ratios and geological circumstances), the fossil wood origin of petroleum theory, and lastly, the association of oil with dynamically disturbed marine coals.

A penultimate digression discourses on oil in Great Britain (an unhappy subject), future development in Burma, possibilities in north-west India and Australia. The valedictory is, curiously, on "Speculative Geology." But surely the whole book is essentially this? At all events, given a similar frame of mind, the reader will probably not find his time wasted.

Popular Astronomy.

Modern Astronomy: its Rise and Progress. By Dr. Hector Macpherson. Pp. viii + 196. (London: Oxford University Press, 1926.) 6*s*. net.

THIS little book consists of a series of ten lectures delivered by the author as Thomson lecturer in natural science for the session 1925–26 at the Aberdeen United Free Church College. The subject matter of modern descriptive and physical astronomy is treated historically, particular attention being given to those ideas of earlier times from which modern ideas have most directly developed. The period covered by the survey extends from the time of Copernicus up to the present day. Prominence is given to the views, not only of the recognised leaders in the subject, but also of some of those whose conclusions are less widely accepted and have, perhaps, not received the attention which they deserve. Quotations occur frequently throughout the book.

The treatment is lucid, interesting, and in the main accurate, and the book should prove useful, especially to amateurs with little time for a detailed study of the subject. Those with a slight previous knowledge of astronomical ideas and nomenclature will receive the greatest benefit from its perusal. There are a few mistakes which are not of the first importance, but should be removed in possible future editions. Thus on p. 96 it is stated that Lebedeff verified the *law* of radiation pressure, and on p. 123 Eddington's theoretical researches are said to have *confirmed* the pulsation hypothesis of Cepheid variation. The book is well produced and pleasant to handle, but would have been much improved if the proofs had been read more carefully. There are several misprints which make meaningless the sentences in which they occur, and in one instance at least (p. 110) a false meaning is given when the distance of 61 Cygni is recorded as about forty million (instead of billion) miles. On the whole, however, the book is substantially trustworthy, and can be recommended to those requiring a book of its type.

(1) *The Romance of Comets.* By Mary Proctor. Pp. xiii + 210 + 16 plates. (New York and London: Harper and Bros., 1926.) 7s. 6d. net.
(2) *Legends of the Sun and Moon.* By Mary Proctor. Pp. 159. (London, Calcutta and Sydney: George G. Harrap and Co., Ltd., 1926.) 1s. 3d.

(1) "The Romance of Comets" is essentially a book for leisure reading, and is written primarily for those possessing little or no knowledge of elementary astronomy. Throughout, considerable space is devoted to anecdotes and reminiscences, most of which contribute materially to the readableness of the book, although one or two are interpolated rather unnecessarily. The titles of the nine chapters indicate the scope of the contents, as, for example, (1) comets as portents, (4) comets in distress, (6) return of Halley's Comet in 1910, (8) meteor streams. Chap. ii., "Comet-Hunting as a Hobby," which contains a delightful account by the late Prof. Barnard of "The house that was built with comets," should win more than one reader to the ranks of amateur astronomers.

In spite of the use of simple language and several helpful analogies, some passages are obscure or convey a wrong meaning (pp. 15, 83-84, 95, 121). The introduction of "Hints for Amateur Photographers," pp. 83-91, is somewhat pointless, as the reader on perusal will be led to infer that the equipment required for cometary photography lies far beyond his means. A few misprints have been passed, the most important being in the footnote on p. 125—*for* 1965 *read* 1985. The type is pleasant to read, and the illustrations are good. On the whole, it may be said that this book will be read with pleasure and interest by those who wish for a simple account of these remarkable objects to which astronomers have devoted so much study and patient observation since the time of Edmund Halley.

(2) In "Legends of the Sun and Moon" Miss Proctor has produced for young readers an interesting collection of myths, superstitions, and customs relating chiefly to the sun and moon.

Relativity.

(1) *Readable Relativity: a Book for Non-Specialists.* By Clement V. Durell. Pp. vii + 146. (London: G. Bell and Sons, Ltd., 1926.) 3s. 6d. net.
(2) *From Kant to Einstein.* By Hervey de Montmorency. Pp. iii + 39. (Cambridge: W. Heffer and Sons, Ltd.; London: Simpkin, Marshall and Co., Ltd., 1926.) 2s. 6d. net.

(1) The title of Mr. Durell's book is somewhat misleading. The book is readable only to those whose familiarity with algebra approaching matriculation standard is very intimate, for it abounds in simple mathematical formulæ. However, for such inquirers it is certainly very readable, and is one of the best expositions of its kind that we have seen. The fundamental principles of the theory are very clearly explained, and almost every general statement is illustrated by a good numerical example, for which many readers will be very grateful. Each chapter concludes with a number of test questions, of which the answers are given at the end of the book. The treatment in parts is perhaps too detailed; thus the deduction of the Fitzgerald-Lorentz equations of transformation occupies eleven pages, although mathematical symbols are used and all the necessary preliminary ground has previously been covered. This tends to obscure rather than to illuminate.

We must dissent from Mr. Durell's statements that the progress of modern astronomy "is due entirely to the successive aids that inventions have given in supplementing the powers of naked eyes and naked hands" (p. 8), and that whenever the separation between two events is real, "there is some causal connection between the events" (p. 77). On the whole, however, the book has given us great pleasure, and can be confidently recommended as a trustworthy and interesting guide to Einstein's theory. This applies particularly to the account of the restricted theory of relativity, to which about five-sixths of the book is devoted.

(2) Mr. de Montmorency's book appears to be a not wholly intelligible attempt to judge Einstein's theory of relativity by the standard of Kant's philosophy. As he puts it: "Kant's doctrines may serve as a canon for judging Einstein's propositions." The chief point seems to be that time cannot be "subordinate to space," as Minkowski and Einstein are said to make it. Mr. de Montmorency insists upon the fact that Einstein is not a metaphysician (without, however, apparently realising that his theory is a scientific and not a metaphysical one); he states that if he were, "he would choose his language with more care," and asserts that "many of Einstein's arguments are open to criticism and contain internal evidence of carelessness." These remarks, however, fail to carry much weight when their author tells us that "Newton accounts for the orbit of a planet

thus: its path is the resultant of two forces; (1) the force from which its initial velocity was derived; (2) the force of gravity pulling it towards the sun." When, a little later, we read that plane Cartesian equations "are always in two unknown quantities and of the second degree," and that by introducing a third co-ordinate we can form the equation to a spiral which "will be in three unknown quantities and of the third degree," our respect for his criticism dwindles to vanishing point. The book concludes with an appendix consisting of "a few Lorentz-Einstein equations of transformation." H. D.

Laboratory Physics.

High Vacua. By Dr. G. W. C. Kaye. Pp. xii + 175 + 4 plates. (London: Longmans, Green and Co., Ltd., 1927.) 10*s*. 6*d*. net.

Vacuum technique is becoming as popular a subject as relativity, but it offers less scope for originality of treatment. Dr. Kaye's book, containing his Cantor Lectures, is later than the others, and therefore contains a few things that his predecessors omit; it is shorter, and therefore omits many things that they contain. It seems to be equally accurate; the section on vacuum pumps—not in our opinion the most important aspect of the subject—is especially complete. The question whether it meets any demand not yet adequately met is one for the publishers rather than for the reviewer.

Notes on Practical Physics: for Junior Students. By Prof. C. G. Barkla and Dr. G. A. Carse. Second edition. Pp. xii + 119. (London and Edinburgh: Gurney and Jackson, 1926.) 6*s*. 6*d*. net.

The second edition of the "Notes on Practical Physics" used by junior students in the University of Edinburgh does not differ greatly from the first. Some experiments have been added in the section on electricity, and corrections have been made. There is an interesting section on treatment of observations and determination of error—a somewhat unusual feature in a book of this standard, but one which is to be welcomed. The tables of physical constants at the end of the volume might well be revised and brought up-to-date.

General Physics for the Laboratory. By Prof. Lloyd W. Taylor, William W. Watson and Prof. Carl E. Howe. Pp. vi + 247. (Boston, New York and London: Ginn and Co., 1926.) 2.40 dollars.

The feature of this attractive volume which first compels the reader's attention is the excellent series of half-tone illustrations from photographs, showing the apparatus set up, ready for use, including all minor auxiliary instruments. The authors point out that this plan does away with the necessity for a detailed description of the apparatus.

The book forms a text-book of practical physics containing nearly fifty experiments covering a course such as might be followed by a student working for a pass degree in Great Britain. An account of the theory of each experiment is given, and the laboratory instructions are formulated in an unusually specific and detailed way. This method is defended by the authors, who point out that even instructions such as these are not too easily followed by a student entering on an unfamiliar field of manipulation. One question, however, suggests itself: Does the carefully drilled student turned out from a modern highly equipped and carefully organised laboratory possess the initiative and resource of his less fortunate predecessor, who was 'thrown in at the deep end'? Granting the position assumed by the authors, the book is excellent and well planned, containing many novel and ingenious experiments. Special mention may be made of an experiment for finding the acceleration due to gravity by means of a freely falling weight, the position of which is registered on a strip of paper by electric sparks jumping at regular intervals.

The statement on page 211 that the Nicol prism was invented by "the German physicist Nicol" requires correction. William Nicol of Edinburgh, who describes himself as a lecturer on natural philosophy, published a description of his polarising prism in the *Edinburgh New Philosophical Journal* in 1829.

General Inorganic Chemistry.

General Inorganic Chemistry. By Prof. M. Cannon Sneed. Pp. vi + 674. (Boston, New York and London: Ginn and Co., 1926.) 12*s*. net.

The author has made an excellent attempt to "reach a proper balance between descriptive and theoretical matter" in this work, and although undue prominence is given to the work of the American Chemical Warfare Service, the book provides a good introduction to the subject. The description of the commoner elements, though not overloaded with detail, deals with essential points, and the simple diagrams, especially those of industrial processes, are admirable. Brief accounts are also given of many of the rarer elements. This descriptive work is relieved at intervals by short historical notes, with excellent full-page portraits of outstanding personalities, and by chapters on such topics as electrolytic dissociation, the structure of the atom, thermochemistry, ionic equilibria, colloids, chemistry in living processes, radioactivity, etc. The beginner may be confused by the use of the two units of volume, the cubic centimetre and the millilitre, and by the inaccurate *definition* on p. 125 of atomic weight as the least weight of the element in a molar volume. Nor will he easily grasp the difference between an ordinary current of positive electricity and the current of electrons on p. 642, but on the whole the style is clear.

No misprints have been noted, but there are a few grammatical faults, *e.g.* 'there are a great variety of them' (p. 480). Such words as 'typal,' 'inhomogeneous,' and 'reactant' have an unfamiliar sound. Aluminium and niton have been re-named aluminum and radon, whilst elements

Nos. 43, 61, and 75 are boldly called masurium, illinium, and rhenium respectively, and a formula is given for the still unknown carbonate of aluminium.

A Text-Book of Inorganic Chemistry. Edited by Dr. J. Newton Friend. (Griffin's Scientific Text-Books.) Vol. 3, Part 2: *Beryllium and its Congeners.* By Joshua C. Gregory and Dr. May Sybil Burr (née Leslie). Pp. xxvi + 342. 18*s.* net. Vol. 7, Part 3: *Chromium and its Congeners.* By Reece H. Vallance and Arthur A. Eldridge. Pp. xxvi + 380. 18*s.* net. (London: Charles Griffin and Co., Ltd., 1926.)

The two new sections of Dr. Friend's "Text-Book of Inorganic Chemistry" deal respectively with (i) beryllium, magnesium, zinc, cadmium, mercury, and (ii) chromium, molybdenum, tungsten, and uranium. They conform so closely to the pattern already established by earlier volumes of the series that very little special comment is called for. It may, however, be said that the type to which the successive volumes conform with increasing definiteness is that of a work of reference, which contains an array of facts which makes it almost impossible for the casual reader to discover any sections which can be read consecutively with any degree of enjoyment. For this reason, indeed, it appears likely that many of those who appreciate at their full value the merits of the "Text-book" will put the new volumes in their appropriate places on the shelf without attempting to 'read' them, but with the definite object of referring to them when a suitable opportunity arises. It may perhaps be regretted that the general editor of the series has discouraged his contributors from 'letting themselves go,' since the whole work might have been transformed by the introduction of a number of chapters in which the individuality of the authors was allowed to stand out, especially when dealing with the more exhilarating topics.

A Systematic Qualitative Chemical Analysis: a Theoretical and Practical Study of Analytical Reactions of the more common Ions of Inorganic Substances. By Prof. Geo. W. Sears. Second edition, revised. Pp. x + 165. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1926.) 10*s.* net.

This book commences with a brief account of the ionic theory of solution together with the laws of mass action and solubility products, and continues with the systematic analysis of cations and, finally, anions. The subject matter contains no new methods of analysis, but is based on the methods of Treadwell and similar standard works. The first section, dealing with mass action and solubility products, has been well written and is easily understood. The later sections, however, are in places somewhat confusing to the beginner. Statements such as "treat the filtrate by (10) and the residue by (2 p.)," or "treat the filtrate by (20). If there is a residue . . . treat by (7)," which are very common throughout the book, do not make the scheme of analysis easy to follow. The book does not seem to have any advantage either in price or subject matter over the numerous other works on this subject.

Organic Chemistry.

A Student's Manual of Organic Chemical Analysis: Qualitative and Quantitative. By Prof. J. F. Thorpe and Prof. M. A. Whiteley. Reissue with Appendix on New Methods of Organic Analysis, by H. ter Meulen and J. Heslinga. Pp. x + 250. (London: Longmans, Green and Co., Ltd., 1926.) 9*s.* net.

It is an indication of the value of this work that a reprint has been required so soon. The new issue differs from the original volume reviewed in Nature, Nov. 14, 1925, p. 707, in one particular only. At the end of the book there is added an appendix of 41 pages by H. ter Meulen and J. Heslinga on improved methods of ultimate analysis. These authors find that, if manganese dioxide is used instead of copper oxide, a lower temperature of combustion can be employed with resultant economy in tubes, etc. They describe a method whereby oxygen can be estimated by hydrogenation and absorption as water, allowance being made for unchanged carbon dioxide which is absorbed by soda lime. Nitrogen is estimated either by hydrogenation, using powdered nickel at 250° as a catalyst and titration of the ammonia produced, or by combustion with manganese dioxide and collection as nitrogen. Similarly, sulphur and the halogens are estimated by hydrogenation to the volatile acids. From the particulars given, several of the methods seem a considerable advance on those usually employed. The reviewer again recommends this book to all students.

Theoretical Organic Chemistry. By Dr. Francis Arnall and Francis W. Hodges. Part 1. Pp. xi + 372. (London: J. and A. Churchill, 1926.) 10*s.* 6*d.* net.

This book has been written on the usual lines of organic chemistry text-books, but suffers from a desire to include too much information in too small a space. An endeavour is made to teach organic chemistry from the beginning to pass degree standard in 360 pages. The result is that a certain amount of explanatory matter has been omitted and the student will probably fail to obtain a clear and intimate knowledge of the subject without further assistance. For students preparing for examinations it is, however, eminently suitable, since it is remarkably extensive in scope, contains nothing unessential, and is quite up-to-date. Not only are the principal types of organic compounds described with the reactions, identification, and commercial application of their simpler representatives, but also there are chapters on synthesis, isomerism, tautomerism, stereoisomerism, ultimate analysis, molecular weight determination and estimation of typical groups. We have noticed that while a description of synthol is given, no mention is made of the more important commercial synthesis of methyl alcohol. The description of methylated spirits (p. 53) is inaccurate. Other errors noted are the formulæ of nitrolime (p. 98), phenyl-isocyanide dichloride (p. 103), citric acid (p. 158), anthranilic acid (p. 318), while Liebermann is misspelt on p. 121.

Dyestuffs and Coal-Tar Products: their Chemistry, Manufacture and Application. By Thomas Beacall, Dr. F. Challenger, Dr. Geoffrey Martin and Dr. Henry J. S. Sand. (Based on Chapters appearing in "Industrial and Manufacturing Chemistry: Organic.") Fourth edition revised. (Manuals of Chemical Technology, 1.) Pp. xi + 168. (London: Crosby Lockwood and Son, 1926.) 16*s.* net.

THIS book forms one of a series of manuals of chemical technology compiled with the object of giving concise but sufficient information concerning the manufacture and utilisation of chemical products of great industrial importance. The first edition was produced during the critical year of 1915, when "the lack of an English book on the subject, the sudden stoppage of the supply of German fine chemicals, and the preparations of the British Government for the establishment on a large scale of the synthetic dye industry in this country, all combined to provide opportunity and justification for the appearance of the book." The authors were not disappointed in their object; the book met with a ready appreciation, and has now reached its fourth edition.

Within the limits of 156 pages a mass of valuable and accurate information is comprised dealing with: (1) coal tar and coal-tar products; (2) the synthetic colouring matters; (3) natural dyestuffs; (4) the dyeing and colour-printing industry; (5) modern inks; (6) saccharin and other sweetening chemicals; (7) modern synthetic drugs; and (8) photographic chemicals. Each of the eight chapters is prefaced by a list of the titles and authors of standard works on the subject dealt with therein, and contains a short historical or descriptive introduction, and usually also some statistical data.

In the preface to this edition the authors refer to the strenuous efforts that have been made since 1915 in Great Britain and other industrial countries to establish dyestuffs and allied industries on a scale commensurate with national needs; and they express the hope that this new position is reflected so far as is possible within the modest limits of their book. A critical examination of the new edition from this point of view is on the whole disappointing; many of the manufacturing processes described have long been obsolete, as, for example, the preparation of ketones (p. 22), of saccharin (p. 125), and of indigo (p. 51); and, further, no statistical data later than 1913 are included. But this book is evidently not written for the critical reader, otherwise the fairly numerous errors in nomenclature and formulæ that crept into the first edition could not have escaped correction in the fourth.

M. A. W.

Clinical Laboratory Methods.

A Manual of Clinical Laboratory Procedure: for the Use of the General Practitioner. By Dr. Robert A. Kilduffe. Pp. 287. (London: Henry Kimpton, 1926.) 12*s.* 6*d.* net.

IT is regrettable that the value of clinical laboratory investigations is not realised by many physicians; anæmia is sometimes treated for months without a blood-count having been carried out; dyspeptics are rarely given a test-meal before necessity compels them to be referred to hospital or consultant, and many cases of nervous and mental disorder reach a comparatively advanced stage before lumbar puncture is performed. It is easy to find the reasons for this neglect. The average general practitioner has little time to spare for the laboratory, and expense frequently prohibits consultation with a pathologist. There are, however, many laboratory tests which can easily and rapidly be carried out by the practitioner himself. The object of Dr. Kilduffe's book is to indicate those which are likely to be of value and to assist in the interpretation of their results. There could not be a better manual for the physician who is willing to devote a little time to laboratory work.

Of particular interest are the chapters on the equipment of the laboratory and home-made laboratory devices, though the limitation of the use of such an instrument as the home-made colorimeter must be borne in mind. The arrangement of the book is that usually adopted for laboratory manuals; there are chapters on urine, blood, gastric contents, cerebro-spinal fluid, etc., in which the appropriate tests are described. Few individual methods are given under each heading, the object being to indicate only those most likely to be of value to the practitioner. The discussion of the results and their interpretation is valuable, but more stress might have been laid on the association of the presence of lactic acid with achlorhydria in the diagnosis of gastric cancer. The indexing is not very complete, but a list of common diseases and clinical conditions with suggested laboratory investigations will be a useful guide to the physician.

Laboratory Outlines in Bacteriology and Immunology. By Prof. John F. Norton and Prof. I. S. Falk. Pp. viii + 114. (Chicago, Ill.: University of Chicago Press; London: Cambridge University Press, 1926.) 10*s.* net.

THE matter of this small book is in strict accord with its title; it is a programme of work for a course of instruction in bacteriology, serology, and immunology. Few details of actual work are given, and the book is essentially one for the teacher and may be a helpful guide to him, though of course any teacher worthy the name will arrange his own courses of instruction. The sections seem to be well devised and to cover most of the problems of pathological and medical bacteriology, but agricultural bacteriology is scarcely touched. The contents conform with American practice; thus, we find no mention of "carbolic acid coefficients" under disinfection, or of the "Dreyer method" under agglutination. Directions are given for the preparation of the dye for Leishman's stain, which is now stocked by all dealers, and the impression is given that students are unrestricted in the performance of experiments on animals. A book of this kind must necessarily have a limited circulation, hence perhaps its high cost. R. T. H.

Technical Electricity.

Electric Circuit Theory and the Operational Calculus. By John R. Carson. Pp. ix + 197. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1926.) 15*s*. net.

THIS book is the outcome of a course of lectures given by the author in 1925 to the University of Pennsylvania. After a brief introduction to electric circuit theory, a critical exposition is given of the Heaviside operational calculus. It is pointed out that Heaviside's method is known to and employed by only a few specialists. This is partly due to the intrinsic difficulties of the subject and to obscurities in Heaviside's own exposition. In the present work the Heaviside rules are deduced from an integral equation.

The second part of the book deals with the propagation of current and voltage in transmission lines and wave filters. The simplest of the transmission systems is the non-inductive cable, the theory of which was given in Kelvin's early work on the possibility of trans-Atlantic telegraphy. In particular, the physical phenomena can be studied best, as the author shows, when we consider an infinitely long cable. We are sorry that the skin effect in cylindrical cables and the eddy current losses in them are not dealt with, as they give such an excellent illustration of Heaviside's methods.

The author considers that Heaviside overestimated the value of power series in solving problems. In particular he objects to Heaviside criticising those mathematicians who prefer solutions in the form of definite integrals. It is possible that power-series solutions have only a restricted utility in some cases and that definite integrals have proved useful when suitable tables are available. We think, nevertheless, that Heaviside's criticism was justified. Poisson, for example, expressed the capacity coefficients of two spheres as definite integrals, and Dr. Barnes, now Bishop of Birmingham, expressed them as double gamma functions, but when engineers want their values they use series formulæ or interpolate from Kelvin's tables. The book can be recommended to mathematical physicists.

Alternating Current Rectification and Allied Problems: a Mathematical and Practical Treatment from the Engineering View-Point. By L. B. W. Jolley. Second edition, revised and enlarged. Pp. xxii + 472 + 27 plates. (London: Chapman and Hall, Ltd., 1926.) 30*s*. net.

WE were pleased to see that a second edition of this book has now been published. Whilst alternating current seems to be almost universally used in large power stations, there is a considerable demand for direct current for auxiliary and control circuits. To obtain this current it is now usual to employ some form of rectifying apparatus. The rectified current is generally pulsating, and it is necessary to know the magnitude of the ripple in it. The author, therefore, starts by giving an account of Fourier's theorem and the methods employed in practice to find the harmonics. From the engineer's point of view this chapter will be found very satisfactory.

Recent improvements in the design and manufacture of all kinds of rectifiers have been noted in this edition. There are also three new chapters on the installation of thermionic rectifiers, on radio supplies, and on inverters. It is pointed out that while the mercury rectifier is essentially a heavy current low-voltage device, the thermionic rectifier is a high-voltage device, and can only be efficiently used when the rectified voltage is of the order of thousands of volts.

The chapter on radio supplies will be of interest to all broadcast receivers. When the house is supplied by alternating current, a rectifier can be used to charge the batteries generally used with a receiving set. In most cases the interest per annum on the capital outlay of a rectifier is less than the cost per annum of charging the batteries by sending them to a local contractor. Where direct current supply is available, the charging can be easily done, but care must be taken not to earth the companies' mains. This can be provided against by inserting a two-microfarad condenser between the radio set and the earth.

Elements of Alternating Currents and Alternating-current Apparatus. By Prof. J. L. Beaver. Pp. 370. (New York and London: Longmans, Green and Co., Ltd., 1926.) 18*s*. net.

THIS book proves that alternating-current theory is settling down into orthodox lines. It is written partly to help the average student and partly to help the more ambitious student who is anxious to master the complete theory. Numerous examples are given at the end of many of the chapters which the ordinary student will not have much difficulty in doing. There is a 'snap' about some of these questions which we miss in Great Britain. For example, p. 67: "Prove that $L\frac{di}{dt} = \ldots\ldots = $ what?" p. 213: "The exciting current is what per cent. of the name-plate current?"

The capacitance (capacity) of a conductor is defined, but the capacitance of a condenser is not. We do not agree with the author when he says that effective current, effective voltage, and average power are not ordinary algebraical quantities and cannot be handled by ordinary algebraical methods. We think that they are perfectly real numbers. If we want to combine alternating currents and voltages, we have to use the parallelogram law, but the effective values of the components and their resultants are real numbers. The author has been successful in simplifying considerably the theory of polyphase currents and machines. If we neglect the 'losses' in a machine we get, as a rule, a clear idea of the principle of its working, and we can then gradually build up a more accurate theory. This method is to be commended.

Use of Electric Power.

Electric Trains. By R. E. Dickinson. Pp. xii + 292. (London: Edward Arnold and Co., 1927.) 16*s.* net.

There are few industries in such a rapid state of development as electric traction, and there are few in which the literature of the subject is, comparatively speaking, so small. Some of these books are quite out-of-date; others are too advanced, demanding a knowledge of mathematics that few possess; and others contain little beyond a great mass of statistics and data which, while useful to the specialist, are of little help to students and ordinary railway engineers. This book is specially written for the latter two classes and will prove helpful.

To meet the ever-growing competition of tramway and motor-bus traffic, it is necessary to speed up the trains on suburban lines. With steam-hauled trains the acceleration is rarely so great as "half a mile per hour" per second, whereas an acceleration of 1·5 m.p.h. per second can easily be obtained by electric traction. Slipping of the wheels takes place much more readily with steam-operated trains, owing to the pulsating nature of the tractive force. There is also much less wear of the rails when the trains are operated electrically.

The author's chapter on the mechanics of train movement can be readily understood by any one having an elementary knowledge of mechanics. The control systems and the methods of making rheostatic calculations are clearly described. Train resistance curves are given, so that even although this resistance varies considerably with local conditions, useful approximations can be made. It will be remembered that the Advisory Committee appointed by the British Ministry of Transport reported in favour of standardising the supply pressure at 1500 volts direct current. From the data given, it appears that in practice modern railway engineers prefer this system to the single-phase system.

The Use of Power in Colliery Working: a Treatise on Mining Costs and Machinery Designs and Management. By John Kersopp. Pp. xxviii + 580. (London: H. F. and G. Witherby, 1926.) 40*s.* net.

During the past twenty-five years, mining engineering has been revolutionised by the substitution of power for hand labour in the majority of the operations involved in the winning and working of collieries, and we seem to be within sight of the time when the pick and the shovel will have a place in the museum only. It is perhaps inevitable that the advent of machinery should have led to a slackening of physical effort on the part of the manual worker, so that the net result is that the output per man-shift has remained stationary. Some idea of the variety of machinery at the command of the miner is given by the book under review, but it is by no means an exhaustive treatment of the subject. For example, little or no reference is made to compressed air (an important omission) or to ventilating machinery. Nor is any attempt made to describe banking out or screening arrangements at the surface, amongst which certain modern devices such as decking machinery are of great interest at the present time.

Little attempt is made to explain the mechanics of the machinery described. The chapter on winding engines would have had more value had moment diagrams been given for the principal types of winding engines, and the chapters on pumping would have been similarly improved had the characteristic curves of the different types of pumps been illustrated. In the descriptions of electrical plant there is no reference to the synchronous induction motor, or to the cascade, or A.C. commutator motor. The book indeed appears to be largely a collection of catalogue descriptions and illustrations of a medley of types of apparatus. It contains a considerable mass of useful information badly digested. The use of many photographs showing external details only, and the lack of diagrams illustrating important features, militates against its usefulness. Moreover, the invidious practice of singling out the names of certain firms for special mention is to be deprecated.

At the end is given supplementary information on the various chapters, but it is difficult to understand why these were not included in the chapters themselves. Appendices giving useful information as to fluctuations in costs of materials, wages, etc., are given, but their connexion with the subject matter of the book is not clear. The book contains useful information but will have a limited utility.

Douglas Hay.

Miscellany.

Organised Publication: a Connected Series of Proposals relating to the Publication and Record of Scientific and Technical Information. By J. F. Pownall. Pp. 91. (London: Elliot Stock, 1926.) 5*s.* net.

Mr. Pownall's work is a plea for the international standardisation of scientific literature in respect of page size, spacing of perforations of sheet or leaf, the definition of subject headings in terms of an international code, and the prefixing of the standardised subject headings to each article. Scientific literature, in short, is to be built up from standardised units to be circulated temporarily in volume form, but ultimately to be resolved into unit form and to be housed in temporary binders.

Within recent years some progress has been made in the direction of the standardisation of the pages of the higher class of scientific periodicals, both as regards the quarto and octavo sizes. As the movement appears to have slowed down, it is probable that scientific workers are content with the progress realised and that present methods of publishing the *Proceedings*, etc., of the learned societies are sufficient for economical filing. It is, of course, difficult to say precisely how far size standardisation should be pushed; but it is tolerably clear that works of the same bibliographical type and dealing with the same or cognate subject matter should be issued in substantially the same size and style. The Patent Offices of the world have long accepted the imp. 8vo size for their specifications—with great benefit to their users ; but trade catalogues continue to be issued in oblong folio and other strange sizes which defy classification and shelf arrangement. The trend of book classification is, no doubt, toward uniformity ; but this is due, not to any great or general enthusiasm for uniformity on the part of librarians, but to their appreciation of the fact that advanced schemes of book classification—and nowadays elementary schemes are retained only in the smaller libraries—must emanate from libraries which possess the requisite material, training, and financial support. It is, however, doubtful whether these advanced schemes of classification are suitable for the analytical treatment of the contents of periodicals.

Mr. Pownall has, we think, concentrated his attention too closely upon the mechanics of classification. His proposals go far beyond the merits of the case which undoubtedly exists for further standardisation. Publishers have to consider the wishes and prejudices of their clients. No book-lover would accept a book which contained, in addition to the wounds inflicted by machine sewing, the standardised perforations of Mr. Pownall.

The Radcliffe Infirmary. By Alexander George Gibson. Pp. xi + 316. (London : Oxford University Press, 1926.) 18*s*. net.

DR. A. G. GIBSON, who for many years has been attached to the staff of the Radcliffe Infirmary, Oxford, has given us in the present volume a lively and richly documented account of the history, management, staff, and activities of this institution. Founded in 1759, but not opened to patients until more than ten years later, the Radcliffe Infirmary has always been one of the leading provincial hospitals in England, and, owing to its association with the University of Oxford, occupies a prominent position in medical education. From the very first it was recognised that the Infirmary was to provide opportunities for the study of disease for the future medical graduate. In 1913 the teaching of pathology as a university subject was inaugurated by Sir John Burdon Sanderson, with the result that considerable improvement took place in the mortuary accommodation at the Infirmary. Since the War the whole of the medical staff of the Infirmary has contributed towards university teaching, including the Regius professor of medicine, who occupies the post of consulting physician.

To many the most attractive part of the work will be the biographies of the various members of the medical staff, which numbered among others John Kidd, James Ogle, Charles Daubeny, William Greenhill, Sir Henry Acland, George Rolleston, and Sir William Osler. From the concluding chapter we learn that within the last forty years several new departments have been added to the Infirmary, such as the Dental Department in 1886, the Dermatological and Ear, Nose, and Throat Departments in 1906, the X-ray Department in 1907, the Pathological Department in 1913, and the Orthopædic and Neurological Departments in 1918. The appendix contains, among other items, lists of legacies from 1761 to the present time, preachers of the Radcliffe Infirmary sermon from 1771 to 1862, and members of the committee of management from 1848 to 1921.

Shipbuilding and the Shipbuilding Industry. By J. Mitchell. (Pitman's Common Commodities and Industries Series.) Pp. xi + 116. (London : Sir Isaac Pitman and Sons, Ltd., n.d.) 3*s*. net.

FOR the student of naval architecture and shipbuilding there are many text-books. With these this little volume is not intended to compete. It is written almost entirely for the layman who wishes to gain an insight into the position of the shipbuilding industry, the organisation of a shipyard, and the work involved in the designing, building, and fitting-out of ships. In many industries there are technical matters of general interest, and here the reader will find clear explanations of some of the methods of the drawing office and building slip.

The author is himself a shipyard manager and also a teacher, and the headings of some of the chapters indicate his method of treatment. After a brief review of shipbuilding statistics, he deals in turn with types of ships, the shipyard, the designing and the building, launching, and maintenance of ships. There are few more anxious moments than those prior to a launch. A mishap may be disastrous, as was the case of the *Independencia*, launched on the Thames in 1874. Mackrow, who launched so many fine ships at Blackwall, used to say that he never thought of a launch without the *Independencia* appearing like a phantom before his eyes. As Mr. Mitchell says, launching a ship is not a ' pretty-pretty ' spectacle got up as an episode in its career, but " the real matter is the serious problem of shifting a weight of some thousands of tons through several hundred feet by means of innumerable pieces of wood and a few hundredweights of soft soap and tallow." His description of the methods employed is one of the most interesting things in the book.

The Book of the Aeroplane. By Capt. J. Laurence Pritchard. Pp. 255 + 24 plates. (London : Longmans, Green and Co., Ltd., 1926.) 7*s*. 6*d*. net.

CAPTAIN PRITCHARD's book is written with the advantage of a good deal of personal experience. It does not profess to deal in any detail with pre-War flying, but gives a very full account of the present position of heavier-than-air machines. Whether these will eventually be called ' airplanes ' rather than ' aeroplanes ' remains to be seen, though there is a tendency to substitute the former term in some quarters. The author makes an interesting forecast of future developments, which will, in his opinion, be eventually much more pacific than warlike. The book is profusely illustrated and contains a useful glossary.

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Supplement to NATURE

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The Bicentenary of Newton's Death.[1]

By The Lord Bishop of Birmingham, Dr. E. W. BARNES, F.R.S.

WE meet to-day to commemorate by a religious service the bicentenary of the death of Sir Isaac Newton. It is quite characteristic of the attitude of the English people towards the national Church that a group of mathematicians and astronomers, laymen all, should have desired to have such a religious service as the conclusion of their celebrations. They know, as every educated man knows, that Newton's splendid achievements, enshrined in his "Principia," finally overthrew certain beliefs which at the time of the Reformation were held by all, Catholics and Protestants alike. They know that the contest in which he won the decisive victory was but the first of a number—I mention geology, Darwin and Biblical criticism—in which scientific method has successfully challenged views associated with traditional theology. None the less, they expect the English Church to be liberal, to join unreservedly in praising the genius of a great Englishman and in thanking God for his life-work. Their expectations are not disappointed, for the English Church is as illogical and, at its best, as sensible as the average Englishman.

FIG. 1.—Portrait by Kneller, 1689.

From an engraving by Barlow, in the possession of the National Portrait Gallery.

To foreigners we are always something of a puzzle. The Thirty-nine Articles of our Church, to which every clergyman still subscribes, belong to the pre-Copernican period of knowledge. They were in substance drawn up only ten years after a printed copy of Copernicus's great treatise was put into his hands on his death-bed in 1543. Our Prayer Book was last revised in 1662, a few years before the ideas of the "Principia" first took shape in Newton's mind. The Church has thus apparently ignored the vast change in human thought which science has made since the Renaissance. Its theology seems to be associated with crude beliefs as to the history and structure of the universe which were held in antiquity. But, in fact, its theology has been continuously re-shaped by its leading divines, and the process has not yet ended. So Newton lies under a monument in Westminster Abbey, and Darwin was buried near-by in the same great church. "Doubtless in each case such honour was rendered by order of the Government," a foreigner would conjecture. No: English clergymen still have the power to say who shall be buried in Westminster Abbey.

It is then with no misgivings, with no hesitation, that to-day we meet to praise Newton in the parish church of the town where he went to school. Six miles away he was born, on Christmas Day, 1642, a puny infant so small that they might have put him into a quart mug. In this neighbourhood he lived for the first eighteen years of his life, an inventive, meditative boy obviously unsuited to farm the small manor which his father had owned.

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[1] A sermon delivered in Grantham Parish Church on Sunday, Mar. 20, in connexion with the commemoration of the two-hundredth anniversary of the death of Sir Isaac Newton arranged by the Yorkshire Branch of the Mathematical Association. Other addresses will be found in succeeding pages.

Whence came his genius? We cannot say. His father's family had been settled in this neighbourhood for about a century. His mother was the sister of a local vicar, on whose advice he was finally sent to Trinity College, Cambridge. There seems to have been no trace of mathematical ability in any of his forbears. But, so far as environment went, he was a son of the parsonage. His father died before his birth. His mother's second husband was a clergyman. The boy was thus brought up under clerical influences. Such influences must have done much to give him the puritan austerity, the combined piety, frugality, and generosity, and the interest in theology which he retained throughout his long life. It is a mistake to believe, in consequence of a well-known gibe of Voltaire, that Newton only turned to theology when his powers failed because of the strain of the *anni mirabiles*, the marvellous years, in which the "Principia" was produced. His theological interests, like his piety, persisted throughout his life. We may regret that he did not confine his activity to a domain where his powers were supreme. We must admit that his theological writings were of little permanent value. Yet they show extraordinary width of reading and no little perspicuity. The publication of Newton's tract on the textual criticism of two New Testament passages was deplored by an English Bishop so late as the middle of the nineteenth century. But Newton was correct in his judgment: and the draft revision of the Prayer Book now before the public omits the famous verse of the three heavenly witnesses (1 John v. 7) to which he took exception.

It is well known that Newton refused to take Holy Orders, and that he was only enabled to remain as a fellow of his College while holding the Lucasian professorship at Cambridge by virtue of a special patent from the Crown. There seems to be no reason to doubt that he was urged to take orders in later life, and that, had he done so, he might have received substantial ecclesiastical preferment. To reward a man of science by making him a bishop or a dean seems incongruous to us to-day. But it must be remembered that the connexion of the Church with education and learning was far closer then than now: and the mastership of the Mint, the reward which Newton actually received, was not especially suited to his gifts. Newton's probity and industry while he had care of the coinage have earned the praise of historians and economists: but a lesser man might have done equally valuable work.

Why did Newton, with his high character, sincere piety, and interest in theology, steadily resist ordination? What were his religious views? The question has at times been somewhat acrimoniously debated. But, as a fuller knowledge was gained of the papers preserved in manuscript after his death, it finally became clear that he could not bring himself to accept the Athanasian doctrine of the Trinity. He was an ethical theist with a profound veneration for Christ: but he was not prepared to allow that the Nicene formula adequately expressed the inter-relation of the divine and the human in the person of Christ. As to the miracles of the New Testament, and in particular the virgin birth, he had no doubts. In that, as in his sympathy with Arianism, he was a child of his age. Of that age also were his views of the so-called Mosaic cosmogony of Genesis. In an interesting letter written in 1680, when his intellectual powers were at their zenith, he expressed the opinion that Moses "described realities in a language artificially adapted to the sense of the vulgar." Leibniz at the same time showed a far more modern understanding of the geological process.

When we pass to Newton's metaphysics, and in particular to his views as to space and time, we reach ideas which the theory of relativity has shown to be of transcendent importance. Whence did Newton get the conceptions of absolute space and absolute time which underlie the laws of motion which he formulated? I think it is not to be doubted that they came from the group of divines honourably known as the Cambridge Platonists. The importance of these men in the development of English religious thought has become increasingly clear in our own day, and more especially to English Modernists whose endeavour to re-shape Christian theology merits the close attention which it receives. More and Cudworth were both older contemporaries of Newton: each was living when the "Principia" was written; and More's spiritualised space corresponded closely to Newton's famous scholium. God, as Newton put it, "is not eternity and infinity but eternal and infinite; He is not duration and space, but He continues and is present. He continues for ever and is present everywhere; and by continuing to be always and everywhere, He constitutes duration and space." In this passage Newton breaks up the space-time continuum: duration and space were separated. But the metaphysic becomes strengthened rather than weakened if, modifying Newton, we say that "by continuing to be always and everywhere God constitutes space-time." Space-time so conceived becomes the primal stuff of the physical universe through which and in which God's purpose of creation is achieved. God thus constitutes the nexus out of which man has emerged.

It is my purpose to-day to set before you Newton's religious sympathies and thoughts, so I make no attempt to describe the great system of dynamical astronomy of which his laws of motion are the foundation. As it sprang from his brain it was marvellously complete and well-nigh perfect in expression. To make it he invented a new calculus which in his hands was so flexible that, to disarm criticism, he gave it geometrical form. A new era in mathematics began with his discoveries. Instead of slow and painful progress, "line upon line, here a little and there a little," Newton jumped forward; and, as the centuries pass, men will continue to marvel at his splendid genius. In our day a great thinker has made an immortal name for himself. But it is a mistake to think, as some imagine, that Einstein has overthrown Newtonian dynamics; he has rather brought gravitation itself within a modification of his predecessor's scheme. Newton's fame is secure. But he, were he alive, would be the first to praise the achievements of those who carry on his torch of knowledge. Did he not, with genuine humility, liken himself to a boy playing on the sea-shore, now and then finding a smoother pebble or a prettier shell than ordinary, while the great ocean of truth lay all undiscovered before him?

Palmer Clarke] [Cambridge.

FIG. 2.—Portrait by Thornhill, 1710, in the drawing room of Trinity Lodge, Cambridge.

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The mathematician, like the poet, is born, not made. The science of mathematics is for the few, endowed with special ability which the chances of life permit to be trained and developed. But the conclusions of the mathematician have an interest for multitudes who cannot understand his technique. Newton, in finally establishing the truth of Copernican astronomy, made humanity enter upon speculative inquiries of the highest importance.

What is man's place in the universe? How is he related to the purpose immanent in the whole? Newton gave little indication that he realised how extensively his work bore upon such inquiries, though there is one interesting passage in his writings where he asks: "If all places to which we have access are filled with living creatures why should all these immense spaces of the heavens above the clouds be incapable of inhabitants?" Reticent though such a sentence is, it was Newton who finally forced the educated world of men to recognise the meanness of man's domicile. The earth had been the centre of the universe: Newton revealed it as a humble satellite of the sun. It needed but recognition of the fact that our sun is but one of millions of stars and man's outlook was transformed. Are there no other stars in the galactic universe which have satellites? We cannot believe it. Are those satellites devoid of life? It is incredible. Has life always taken the same evolutionary course as that which has led to the creation of man upon this earth? Has such evolution never progressed beyond the stage at which man now finds himself? Each question we are practically forced to answer in the negative; and, when we give such answers, what is man in the great scheme of things? Though Newton has been dead two centuries, it is only in our own day that his countrymen, in the mass, are asking the questions to which his discoveries inevitably led.

On the fine statue by Roubiliac which takes the place of honour in the ante-Chapel of Trinity, there is inscribed the line

> Qui genus humanum ingenio superavit,

"who in genius surpassed the whole world." It is the tribute of Lucretius to Epicurus, and a greater than Epicurus merits the praise. Wordsworth saw that statue, an inspiration to many an undergraduate before and since his day; and wrote the lines:

> The marble index of a mind for ever
> Voyaging through strange seas of Thought, alone.

But through stranger seas than Newton ventured has he set men voyaging alone. What is our destiny, as individuals and as a race? Made of dust and water, specks on a small globe, apparently of no special importance in the vast range of creation, we live for but a tick of the astronomer's clock. Light reaches us to-day which began its journey before humanity had appeared upon this earth. Are we, then, of any importance in God's sight? Have we, as individuals or as a race, any permanence? Are we, after all, such stuff as dreams are made of? I give the old answer: "the things which are seen are temporal, the things which are not seen are eternal." The body returns to dust and water; but the mind, which ranges through space and time with a freedom that partakes of the divine, shall not perish. The spirit of a man who strives for truth and seeks goodness belongs to the realm of the eternal.

Here it is fashioned by labour, by self-discipline, by reverence and love. Elsewhere in its perfection it shall have a richer existence. Does it matter that we are little more than point-instants in space-time? I think not; for eternal values are not measured by rods and clocks, nor are they to be found in the blind forces of Nature. "Not by might nor by power but by my spirit, saith the Lord;" and Newton with his simple piety would have accepted the Hebrew prophet's words. As the spirit of man is transformed by the spirit of the Lord, as righteousness and truth fit him to serve God and think His thoughts, he becomes a Son of God and an inheritor of the Kingdom of Heaven.

Newton's Place in Science.

By F. S. Marvin.

TWO men in science have attained a world-wide position and stamped their names on periods marked by the triumph of their theories: and only two. Both were Englishmen, and Newton's position is even clearer and less disputed than Darwin's. Descartes left behind him a Cartesian school and a Cartesian philosophy, but he is not remembered as one of the most eminent men of science. Archimedes and Galileo, the two names one might put beside Newton's as men of science, did not produce a striking, conclusive, and all-embracing theory, such as that which made Newton famous and founded a 'Newtonian' synthesis to last without question or modification for two hundred years.

Though Newton's position is thus unique, it must be studied in connexion with that of others and in its right place in the history of thought. For science being the central thread in the history of mankind, great men of science can less than any other type be isolated and treated as individual phenomena. A Michelangelo, a Shakespeare or a Beethoven, even an Alexander or a Napoleon, may be more legitimately thus isolated and wondered at, but never a man of science; and Newton, like the rest, brought to fruition the labours of others and was himself surrounded by many men close in pursuit of the same truth, dimly perceived, but by him to be clearly articulated and established. This was his special quality as a thinker and a man of science. He was a mathematician, primarily a geometrical mathematician, and he applied a mathematical mind of the most powerful order to the elucidation of problems which were being approached at that time on lines of somewhat vague and quasi-philosophical speculation.

Newton's relation to Descartes is typical. He studied him eagerly as a young man, and was more influenced by him and by Wallis's "Arithmetica Infinitorum" than by any other writers. But his reaction was always critical. Descartes, besides his "Géometrie" published in 1637, elaborated, in his "Principia" of 1644, a physical theory of the universe which stimulated strongly the growing tendency of thought to explain all celestial phenomena by the same mechanical laws which, thanks to Galileo's experiments, had been shown to hold good for phenomena on earth. Descartes therefore must rank as a co-founder, but his work was vitiated by 'metaphysical' reasoning—that is, the assumption that certain results must, by the 'nature of things,' be what investigation had never proved them to be, or had actually proved them not to be. Such were Descartes's assumptions of a number of vortices in the centres of which the sun and planets were swept round, the secondary whirlpools in which the planets moved causing variations of density in the major whirlpool of the sun, and hence deflecting them from their natural circles into ellipses. Newton confronted these imaginary conclusions with the facts observed and the laws deduced from them by Kepler and Galileo, and showed their inconsistency. This appears in the second book of Newton's "Principia," published in 1687 but written long before. He was of the lineage of Archimedes and Hipparchus, and not of Aristotle, and his coincidence with Galileo's work on bodies falling to the earth is the true link in the formation of the first and most powerful of all physical syntheses.

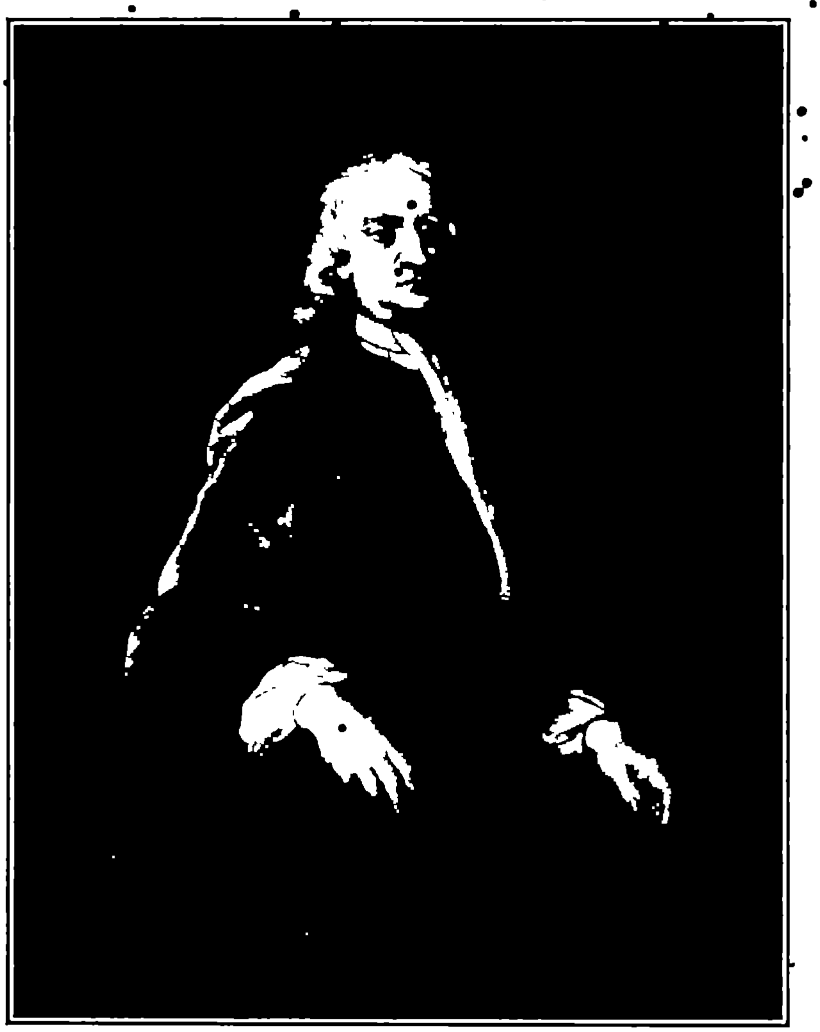

FIG. 3.—Portrait by Vanderbank, 1726, in the meeting-room of the Royal Society, over the president's chair, and given by Mr. C. B. Vignoles in 1841 to the Society.

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Kepler had established his three laws of planetary motion by 1619, but he had been unable to connect them with the law of falling bodies on the earth. His notion of gravity was the quite vague one of the mutual tendency of similar bodies to unite, and in the introduction to his work on Mars he actually committed himself to the mistaken idea that "if the earth and moon were not kept at their respective distances they would fall one on the other, and, supposing them of the same density, the moon would pass through $\frac{53}{54}$ of the distance, the earth through the remaining part."

Then came Galileo's work at Pisa and Padua, of which the full account was published in the "Dialogues on the Two Sciences of Mechanics and Motion" in 1638, though the capital conclusions had been reached some years before. It was in bringing together and proving the identity of Kepler's and Galileo's laws that Newton's genius shone forth. To guess that there was a connexion was easy and almost inevitable for any one who brought the two sets of facts together; to show it accurately and irrefutably was Newton's greatest work. It happened sometime between 1665 and 1679, but the solution was not passed on to others until the autumn of 1684. In the August of that year Halley, who, with several others, had been puzzling at the problem, went to Cambridge to consult Newton about it. Hooke, Huyghens, and Wren, as well as himself, were, he said, all working on the theory that the force of the attraction of the sun or earth on an external particle varied inversely as the square of the distance, but they could not from that law deduce the orbits of the planets. Could Newton find out what the orbit of a planet would be, if the attraction were as the inverse square of the distance? Newton replied that it was an ellipse and that he had worked it out in 1679. He promised to recover it from his notes or his memory and sent it in to Halley in November. On receiving it Halley went again to Cambridge and at this second visit set up those relations between himself and Newton which enabled him to extract the "Principia" from its reluctant author. Halley's was the persuasion and Halley's the financial guarantee. Under this stimulus the first book of the "Principia" was finished by the summer of 1685 and presented to the Royal Society on April 28, 1686. The second book was also completed in the summer of 1686 and deals with hydrostatics and hydrodynamics—motion in a resisting medium—and gives the criticism of the Cartesian theory of vortices to which allusion was made above.

It is interesting to note the similarities in the genesis of Newton's other most famous achievement—the infinitesimal calculus—which he knew as the 'method of fluxions.' Here again many minds were at work, and they were working on an ancient problem to which the Greeks had made a geometrical approach and Descartes had brought much nearer by his approximation of algebra and geometry. Of Newton's contemporaries, several, including especially Fermat, Wallis, and Barrow, had foreshadowed a calculus, by which infinitesimal quantities might be summed and infinitesimal differences in varying quantities measured. Newton's greatness was shown by welding together from the various indications he received from others a sound and practical method which he used for his own purposes so early as 1666, but did not publish until 1693. In its reception he had not the same good fortune as with the law of gravitation, for there was no Halley to steer his ship into port. On the contrary, thanks to his long delay in publication and to the fact that some of his unprinted papers came into the hands of Leibniz in 1676, there was always a doubt as to the priority and independence of Leibniz' method, which was actually printed in 1684. No one need reopen the question now, though it was disputed long and bitterly in the last years of Newton's life. Of Newton's own originality—in the only sense in which a man can in such a matter be original—there is no question; he invented for himself a 'method of fluxions' with his own notation, and it is also unquestioned that Leibniz' method of notation was the more convenient and gained general acceptance. In fact, England, remaining more Newtonian than Newton, was left in the rear-guard of mathematics for more than a hundred years. We may well believe, however, that two great men came by rather different paths to similar, but not identical, conclusions, on a practical question, small in form but big with consequences, on which the ablest mathematical brains of the seventeenth century had been all converging.

It is not within the scope of this article to deal with the modifications in the Newtonian system as a whole which speculations in our own days have introduced; it must suffice to point out the magnitude of the results Newton achieved, and one or two general qualities in his way of thinking, partly characteristic of his time, partly peculiar to himself. These have much to do, first with the enormous success and dominance of the system for more than two centuries, and then with the reaction.

The seventeenth century was the flowering age of mathematics, as the eighteenth was of chemistry and the nineteenth of biology, and the last four decades of the seventeenth saw more forward steps taken than any other period in history. The fact that these developments of mathematics were in the direction of physics, and had so large an effect in the world of practice, was due to Newton's mechanical bent. He had been as a boy fond of making mechanical models, and it was not until later that he took up mathematics theoretically. Euclid was an interesting novelty to him when he went to Cambridge at the age of eighteen, and by that time he could see the truth of the propositions intuitively and went on to Descartes for further light. The great work of those closing decades of the century was predominantly that of Newton, and it included, beside the two fundamental discoveries which we have mentioned, improvements of all kinds in algebra and analytical geometry, and the satisfactory formulation of dynamics, statics, and hydrodynamics with the modern apparatus of calculation." His extreme aptitude for applying a mathematical, geometrical mind to external Nature led to his theory of the propagation of waves and his researches in optics.

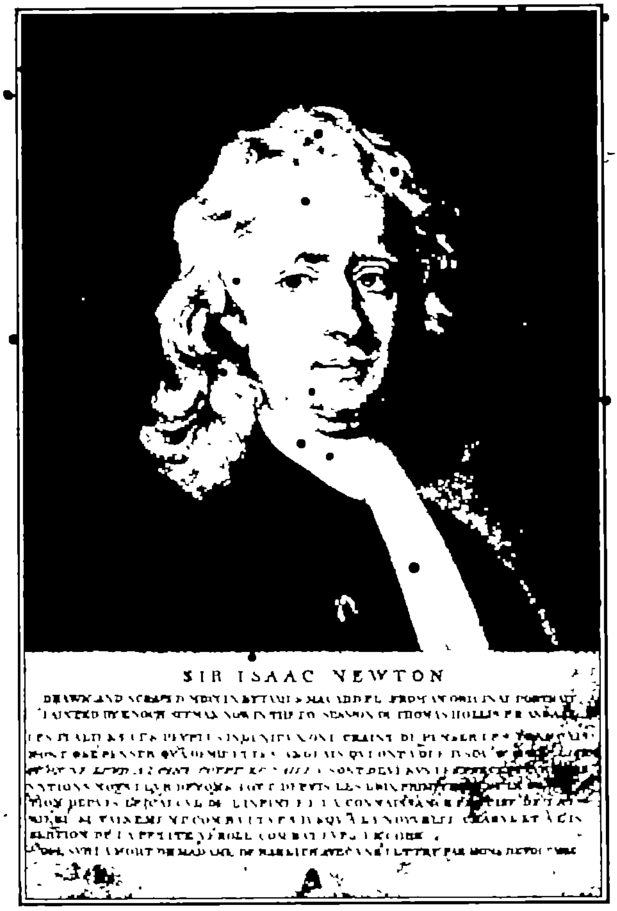

FIG. 4.—Portrait by Enoch Seeman in the dining-room of Trinity Lodge; engraved by MacArdel, 1760.
Reproduced from an engraving in the possession of the Royal Institution.

This was the leading characteristic of Newton's mind and these its chief fruits. But he was attached on another side to the mystical philosophy of his time, and this has recently been studied in a curious work which shows the possible connexions of a theory comprising pure laws with the wildest theological and metaphysical speculations.[1] Newton himself was scrupulously scientific in his deductions: "We must always," he said, "find the laws first, before we speak about their causes." But he was contemporary with the school of Cambridge Platonists and mystics — More, also of Grantham, and Clarke and Cudworth. To them the unknown side of gravity and the concepts of 'ethereal spirits' or 'effluvia' provided a field for the play of unbased and unbridled fancy. In this Newton also often plunged, and it is the strongest testimony to the solidarity of his mind that he never allowed such speculations to deflect in the smallest degree the correctness of his reasoning. Being dissatisfied with the attraction of bodies at a distance, as the final explanation of gravity, he assumed in his own mind the existence of a 'spiritus' or active principle which "penetrates to the very centres of the sun and planets without suffering the least diminution of its forces. . . . For, seeing that the variety of motion in the world is always decreasing, there is a necessity of conserving and recruiting it by active Principle, such as are the cause of gravity. This Principle would be God, and Space is the medium through which God can come in contact with finite objects and creatures —his boundless and uniform Sensorium." Thus the mystery of action at a distance becomes in the light of a mystic philosophy the meeting point of material bodies and spiritual forces.

It is well that these thoughts should be revived and borne in mind, not in any sense as a derogation from the strictly scientific nature of Newton's work, but as pointing three important morals in the general history of thought, as well as the position of Newton in modern science. First, that every thinker is the child of his times and cannot be dissociated from them or understood without them. Newton's philosophy, including therein its science, fits in perfectly with the theology of "Paradise Lost," which was published in 1667, the year after Newton's own *annus mirabilis* of gravitation and calculus. Secondly, that it is quite possible to combine in the same brain the most rigidly positive doctrines about certain aspects of phenomena with highly speculative and undefinable theories about others. Newton is the noblest example of the mind which can shut the door of its laboratory, and leave instruments and notes of research intact, while it proceeds in its oratory to speculate about the unknown and write numerous works on divinity and prophecy. Thirdly, that this absolute and indescribable sphere of Newton's thought, while it does not affect the validity of his conclusions so far as they go, made it certain that revision would come in the fullness of time. That revision began soon after the bi-centenary, not of his death, but of the completion of his capital works. It has not impaired their greatness, but, completing and putting them in their true setting, it has enhanced their glory and shown their author not as an isolated and immutable genius but as a mighty branch of an ever-growing tree.

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[1] A. J. Snow, "Matter and Gravity in Newton's Physical Philosophy" (Oxford, 1926).

One strange paradox and error has come with the whirl of time. The name of the most deeply religious and theological of all great men of science is now often held to describe a purely mechanical, materialistic, and unspiritual hypothesis of the universe. By eliminating the unknown, and attaching the hypothetical forces to matter itself, the system could be turned in this direction. But it is an undeserved and unexpected fate for the author of "The History of the Creation."

Isaac Newton[1]

By J. H. JEANS, Sec. R.S.

WE are met to do homage to the memory of one who was certainly the greatest man of science, and perhaps the greatest intellect, that the human race has seen. We can claim this position for him without arrogance; it is not only accorded him by his own countrymen and co-workers in science, but also by those most capable of forming an unbiassed judgment. Laplace considered that the "Principia" had assured to it for all time "a pre-eminence above all other productions of the human intellect." Lagrange used similar terms, describing it as "the greatest production of the human mind," and confessing himself dazed at such an illustration of what man's intellect could achieve. He added that Newton was not only the greatest genius that had ever existed, but also the most fortunate, for as there is but one universe it can but happen to one man in the world's history to be the interpreter of its laws. Voltaire wrote of him that "if all the geniuses of the universe were assembled, he should lead the band."

As British men of science we may rejoice that this greatest of all men of science was British. We may feel the satisfaction of the French soldier when he thinks of Napoleon, or of the Italian sculptor when he thinks of Michelangelo, the satisfaction of knowing that the greatest man in our own calling was our own countryman. But we may experience also a wider satisfaction. In the words of his monument in Westminster Abbey, "Sibi gratulentur mortales tale tantumque extitisse humani generis decus," we may rejoice that there has appeared so great a glory to the human race.

This afternoon we are to make a pilgrimage to the house which is doubly distinguished as being the birthplace both of the man and of his greatest achievements. This morning we are met in the school in which he acquired the rudiments of knowledge to contemplate the vast extensions that knowledge received at his hands. But before turning to his life's work, let us glance for a moment at his life.

We see him first as a child of delicate health, having indeed been so feeble and undersized at birth that it was scarcely hoped that he could live. At the age of eleven he is sent to school here. He is, on his own admission, far from industrious, and does not in any way distinguish himself at first. But one day, being maltreated by a senior boy, he decides to fight, and wins. This awakens a spirit of emulation; henceforth he applies himself to his studies with a new zest, speedily outstripping his enemy, and in time reaching the top of the school.

We may speculate as to what would have been the effect on the course of his life, and on the history of science, had it not happened that a big boy lost his temper nearly three centuries ago and kicked a small boy, perhaps in this very room. For myself I imagine it would have all been much the same. Whatever he may have done, or not done, in lesson time at school, he spent his leisure time in scientific and mechanical occupations, in making model windmills and water-clocks, or in estimating the force of the wind by the ingenious method of measuring how much farther he could jump with it than against it; he found less pleasure in flying his kite than in experimenting as to the best length of tail and the best point at which to attach the string. When he was taken from school at the age of fourteen to help on the family farm at Woolsthorpe, his mind refused to be tied down to the dull routine of crops and herds, and turned, as though to its natural element, to problems of mathematics and mechanics. When he was driven from Cambridge to Woolsthorpe by the plague, he sat in the garden and "fell into a speculation on the power of gravity"; he "began to think of gravity extending to the orb of the moon," with results which are familiar to all the world.

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[1] Opening address delivered on March 19, in the Old School, King's School, Grantham, at the commemoration of the two-hundredth anniversary of the death of Sir Isaac Newton.

The most outstanding feature of his personality was, I suppose, the intense sincerity of his search for truth. Like all single-minded investigators of Nature, he was continually overwhelmed at the thought of the comparative smallness of his achievement. In the light of all that is known as to the transparent honesty and unaffected simplicity of his character, his oft-quoted comparison of himself to "a boy playing on the seashore, whilst the great ocean of truth lay all undiscovered before me," must be regarded as a perfectly sincere statement of how his great triumphs appeared to him. This modest simplicity, combining with an over-sensitive and profoundly moral nature, produced two outstanding results in his scientific life. In the first place, he suffered fools far too gladly, and spent more than enough time and energy explaining his scientific position to critics who had neither the knowledge nor the capacity to understand. In the second place, he was over-sensitive to criticism, and perhaps over-ready to discover insincerity, unfairness, or intellectual dishonesty in his opponents. He had such an abhorrence of these qualities that the bare suspicion of them infuriated him, so that at times he showed neither chivalry nor common courtesy in controversy.

There has been much discussion as to what must be deemed to be the outstanding qualities of Newton's intellect and genius. First and foremost must of course be placed his stupendous mental grasp and breadth, his capacity for seeing all aspects of a question and so making unerringly the right choice between alternatives which would have seemed equally probable to a less powerful mind. With his accustomed modesty, which seems to have amounted almost to ignorance that his talents were in any way exceptional, he declared that "if he had done the world any service, it was due to nothing but industry and patient thought." So it may have seemed to him, but obviously his genius must have been something more than an infinite capacity for taking pains; this could neither explain the gigantic amount of his scientific output nor the terrific speed with which his results appeared. We must surely add, in extreme measure, the much rarer capacity for not taking pains, or wasting time, over lines of thought that lead nowhere, the capacity of choosing the right course by a clear vision emanating from sound knowledge. In this quality, which is often described by the superficial terms of 'sagacity' or 'ingenuity,' he was supreme: this is the aspect of him which is commemorated on his statue in Trinity Chapel: "Newton qui genus humanum ingenio superavit."

Apart from this, his amazing success must, I think, be attributed largely to the 'all-roundness' of his mental equipment. This exhibited no *lacunae*, his mind working with equal ease and certainty over the whole range from mathematical abstractions to mechanical details. Biot puts it only slightly differently when he says, "Comme géomètre et comme expérimentateur Newton est sans égal; par la réunion de ces deux genres de génies à leur plus haut dégré, il est sans exemple."

There are parts of his works which one cannot read, even now, without being struck, often as by a blinding flash, with the intense modernity of his thought. The artist attributes modern feeling to, say, Bach or Michelangelo, because their complete mastery of their arts led them to perceive, at least in outline, almost everything which these arts were capable of expressing; in a sense music and sculpture do not so much advance beyond Bach and Michelangelo as oscillate round them. With obvious limitations the same is true of Newton. So clearly and so completely had his mind grasped the essential outlines of the physical universe that, time after time, we find his unerring thought travelling much the same path and encountering much the same difficulties as the scientific investigator of to-day.

A striking example appears in the first few pages of the "Principia," where Newton discusses the difficulty of distinguishing between relative and absolute motion, conjecturing that possibly "in the remote regions of the fixed stars, or perhaps beyond them, there may be some body absolutely at rest," but that "absolute rest cannot be determined from the positions of bodies in our regions." Since Newton wrote this the fixed frame of reference of the luminiferous ether has come and gone, and what might have been considered antiquated thought a few years ago could well be transposed bodily into a treatise on Relativity to-day. Similarly, Newton's theory of 'fits of easy reflexion and transmission,' which seemed foolishness until recently, is now seen to be closely allied in principle to Einstein's 'probability-coefficients' for the interchange of energy between atoms and radiation, while his support of a corpuscular theory of light has acquired a new significance from the modern theory of light quanta. As a final example we find him writing to Bentley (Dec. 10, 1692): "It seems to me that, if the matter of our sun and planets and all the matter of the universe were evenly scattered . . . throughout infinite space, it would never convene into one mass; but some of it would convene into one mass and some into another, so as to make an infinite number of great masses, scattered great distances from one to another throughout all that infinite space. And thus might the sun and fixed stars be formed, supposing the matter were of a lucid nature." I doubt if modern cosmogony can give a much better account of the genesis of the stars.

So, although two centuries have elapsed since Newton died, we may expect to hear this morning not only of work accomplished more than two centuries ago, but also of scientific methods and lines of thought that seem entirely alive to us to-day.

Newton's Work in Astronomy.[1]

By Sir Frank Dyson, K.B.E., F.R.S.

WRITING in the year 1738, Voltaire narrates that Madame Conduitt, Newton's niece, had related to him that in the year 1666, Newton, seeing an apple fall in the garden of Woolsthorpe, meditated profoundly on the cause which draws all bodies in a line which, if produced, would pass through the centre of the earth. Voltaire then tries to reconstruct the line of thought which led Newton to the law of universal gravitation. Would it act if the apple were a mile high or ten miles high? If so, might it not act so far away as the moon, and this power, whatever it is, be the same as that which keeps the moon in its orbit round the earth, the planets moving round the sun, and its satellites round Jupiter?

Vague ideas were current as to the forces which kept the planets in their orbits. Descartes put forward a theory of vortices in a fluid medium diffused through space. This gave a possible sort of mechanism suggested by water or air whirling on the earth, but the details could not be fitted to agree with the known facts of astronomy. Kepler had suggested an attraction between the planets varying as the inverse square of the distance and had afterwards substituted the inverse distance. Others before Newton may have suggested the inverse square, but were unable to carry the idea further. Newton was able to bring the hypothesis to the stage at which it could be tested by its agreement with phenomena. Assuming that the force by which the earth attracted outside bodies varied inversely as the square of the distance and at the earth's surface caused a body to fall 16 feet in one second, he calculated that, as the moon is sixty times as distant from the centre of the earth, the attractive force of the earth at that distance would pull the moon inwards towards the earth 16 feet in one minute. He then calculated the actual force necessary to keep the moon moving round the earth in 27 days 7 hours at a distance of sixty times the radius of the earth. It is said, but without much evidence, that Newton used the erroneous value of 60 miles for 1° of latitude of the earth's surface employed by mariners to calculate the earth's radius, and was unacquainted with the more accurate measures of Norwood in 1636, which made 1° of latitude 70 miles. He thus obtained a value one-seventh part too small, and in view of this discrepancy for a time turned his thoughts to other things. He may have returned to the subject a few years later when he became acquainted with the results of Picart's triangulation from Paris to Amiens made in 1669–1670.

Though we do not know the precise date when Newton had satisfied himself of the truth of the law of gravitation, in 1684 it was complete, and he could not only demonstrate to Halley that under a law of the inverse square planets would describe ellipses round the sun, but could also promise to send to the Royal Society the mathematical principles of natural philosophy in which the doctrine of universal gravitation is set forth in order and its manifold consequences deduced.

In Book III. of the "Principia" Newton begins with the astronomical evidence. The four satellites of Jupiter describe equal areas about Jupiter in equal times; and the squares of their periodic times are proportional to the cubes of their distances from Jupiter's centre. The same is true of the satellites of Saturn. The same holds for the motion of the planets round the sun. The moon, too, if the small disturbances caused by the sun are neglected, describes equal areas in equal times about the earth's centre. It follows from the mathematical demonstration in Book I. that the forces which keep Jupiter's satellites in their orbit tend to Jupiter's centre and are inversely as the square of the distances of the satellites from that centre. The same applies to Saturn and its satellites. The movements of the planets round the sun are known to obey these laws of Kepler's with very great accuracy. Consequently this law of the inverse square holds with equal accuracy. The moon, however, does not move accurately in an ellipse, as its apse shifts 3° in each revolution, but this is to be explained by the disturbing action of the sun; but making allowance for this, the force attracting the moon to the earth varies according to the same law of the inverse square of the distance. With the accurate distance of the moon from the earth's centre, the distance it is drawn towards the earth in one minute is calculated, and thus the amount of the earth's attraction at the moon's distance is found. This will be increased 60^2 times at the earth's surface. It is then found to agree exactly with the force which causes bodies to fall at the earth's surface. Thus the force which retains the moon in its orbit is at the earth's surface identical with the well-known property of weight or gravity.

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[1] Address delivered on Mar 19 at Grantham in connexion with the commemoration of the two-hundredth anniversary of the death of Sir Isaac Newton.

Fig. 5.—Portrait by John Vanderbank in the National Portrait Gallery, London.

It is, then, gravity which keeps the planets and satellites in their orbits, and all gravitate mutually towards one another, with forces which vary inversely as the square of the distance between their centres. Newton now investigates whether he can detect any differences in the gravity of different substances. He provided two wooden boxes round and equal; filled one with wood, and suspended an equal weight of gold in the centre of oscillation of the other. The boxes, hanging by equal threads of 11 feet, made a couple of pendulums perfectly equal in weight and figure and equally receiving the resistance of the air. In this way he found that the force of gravity is within 1/1000th part the same for gold, silver, lead, glass, sand, common salt, wood, water, and wheat. That is, if the resistance of the air were absent, all those bodies would fall at the same rate.

Newton shows point by point that gravity is a universal property of all bodies, dependent solely on the amount of matter they contain. This must hold for the planets, and every part of each planet must gravitate to every part of any other planet, and finally every particle of matter attracts every other particle with a force proportional to the product of their masses and inversely proportional to the square of the distance between them. He then shows that two uniform spheres will attract one another as if their masses were concentrated at their centres. This is perhaps the most splendid piece of geometry ever achieved. It appears to have cost Newton a great deal of thought. He says:

"After I had found that the force of Gravity towards a whole planet did arise from and was compounded of the forces of gravity towards all its parts, and towards every one part was in the reciprocal proportion of the squares of the distances from the part, I was yet in doubt whether that reciprocal duplicate proportion did accurately hold or but nearly so, in the total force compounded of so many partial ones; for it might be that the proportion which accurately enough took place in greater distances should be wide of the truth near the surface of the planet, when the distances of the particles are unequal and their situation dissimilar. But by the help of prop. 75 and 76, Book I., and their corollaries, I was at last satisfied of the truth of the proposition as it now lies before us."

The results which follow from the law of gravitation set down in its generality are almost magical. The laws of the movements of the planets round the sun and satellites round the planets follow immediately. Comparison of the dimensions and rate of description of the orbits give the comparative masses of the sun, earth, Jupiter, and Saturn. The sun is 1060 times as massive as Jupiter and 270,000 times (with the parallax Newton used) as massive as the earth. Thus the earth is found to have a mean density of four times that of the sun, and Newton hazards the guess that the earth's density is between five and six times that of water. The effect of the mutual action of the planets on one another is indicated, and the disturbing action of the sun on the moon is shown to give rise to the revolution of the apse and node, the variation and other inequalities of the moon's orbit. The inequalities known to astronomers were explained and new ones predicted. This complicated problem was carried so far as possible by geometrical methods. Newton said he should give up thinking about the moon, for it made his head ache.

The figure of the earth is next shown to be a spheroid. Owing to rotation the equatorial diameters of planets must be greater than their polar diameters. Observation showed that this was true in the case of Jupiter, which revolves very rapidly in 9 hours 50 minutes. By considering the equilibrium of water in two channels from the pole and a point on the equator to the centre of the earth, Newton showed that the equatorial diameter of the earth would be 1/230th part greater than the polar diameter. Assuming a spheroidal form for the earth, he calculated the length of a degree in different latitudes, and the length of a pendulum beating seconds. He compared these with observations made in various places, such as Paris, Cayenne, St. Helena. This investigation served as a great stimulus and provided a theoretical basis for the more accurate determination of the size and figure of the earth.

The general explanation of the tides was a further deduction from the law of gravitation. Newton showed that the attraction of the moon gave rise to forces tending to heap up the water at a point of the ocean directly under the moon and also at the antipodal point; similarly the sun's attraction tended to cause high water directly under the sun and at the antipodal point. He showed how the spring and neap tides would occur, how the position of the sun or moon, north or south of the equator, would affect the tides and how they would vary in different latitudes. By comparing the heights of the spring and neap tides he concluded that the tide-raising force of the moon was 4·48 times that of the sun. Knowing the mass of the sun he finds it should raise a tide of 1 ft. 11 in. in the open sea, and infers for the moon one of 8 ft. 8 in. Newton gave only an elementary theory of the tides, indicating the causes which produced their main features, and left to his successors the difficult problem of a dynamical theory.

Just as the moon produces tides on the earth, so the earth would produce tides on the moon. As the period of revolution of the moon is the same as its period of rotation on its axis, the moon always presents the same face to us. If the moon were covered with water, the water would be heaped up at the part facing the earth and the part diametrically opposite. So Newton infers that the moon has a spheroidal figure, the longer axis pointing to the earth, and being 186 feet in excess of the equatorial diameter.

The precession of the equinoxes is explained as due to the attraction of the sun and moon on the spheroidal part of the earth. Newton had shown how the attraction of the sun on the moon produced a movement of the nodes of the moon's orbit. In other words, a line drawn perpendicular to the plane in which the moon is moving will trace out a cone in 18½ years. He deduced what would be the movement of the nodes of the orbit of a little moon near the earth's surface, revolving in a sidereal day. The same thing would happen, he says, to a ring of moons, whether they did not eventually touch each other or whether they were molten and formed a continuous ring. Next let the ring of moons be attached to the sphere and communicate its motion. Thus the axis of a mass composed of the ring and sphere together will have movement due to the sun of 9″ annually, and the effect of the moon is in the proportion of the tide-raising force of the two bodies. Airy remarks: "If at this time we might presume to select the part of the 'Principia' which probably astonished and delighted and satisfied its readers more than any other, we should fix, without hesitation, on the explanation of the precession of the equinoxes."

A good deal of space in Book III. is given to comets. Tycho Brahe had shown that they moved in the celestial spaces and did not belong to our atmosphere. Newton regarded them as bodies like the planets, but moving in very elliptic, nearly parabolic orbits, and showed how from three observations their paths might be determined. The tails arise from the atmosphere of the heads, their great length and splendour being due to the heat which the sun communicates to the comet when near to it. He notes that the perihelion distance of some comets is very small, that of 1680 being only one-sixth of the sun's diameter from the sun's surface. Owing to resistance it is possible they may, in course of time, fall into the sun. He hazards the suggestion that fixed stars may be recruited by the fall of comets into them, and here may be a possible explanation of the new stars which have appeared from time to time.

There are two other contributions of Newton to astronomy to which I should like to make a brief reference. In the "System of the World," a work which Newton intended at one time to form Book III. of the "Principia," there is a little-known estimate of the distance of the fixed stars. As it was one hundred years before any better estimate was obtained, I venture to direct attention to it.[2] The disc of Saturn, Newton says, is 17″ or 18″ in diameter. It receives 1/2,100,000,000th of the sun's light. If we suppose Saturn to reflect $\frac{1}{4}$ of the light it receives, the whole light reflected from its illuminated hemisphere will be 1/4,200,000,000th of the light emitted from the sun's hemisphere. If the sun were $10{,}000\sqrt{42}$ times more distant than Saturn, it would yet appear as lucid as Saturn now does without its ring. Let us, therefore, suppose that the distance from which the sun would shine as a fixed star to exceed that of Saturn by about 100,000 times. This gives 0″·2 as the annual parallax of a first magnitude star and 0″·002 as its diameter. Newton answers the objection that light may be absorbed in its passage through space, for in that case the remoter stars would scarcely be seen.

We may also recall the fact that Newton was the first person who actually constructed a reflecting telescope. He gives an account in the *Phil. Trans. Roy. Soc.* of the chemical experiments he made for the best composition of speculum metal. The use of pads of pitch on which rouge is spread for polishing mirrors and lenses was invented by him. I believe instrument-makers have found no better materials since.

Returning to Book III. of the "Principia," nowhere has so much been comprehended in so few words as in the law of gravitation. It does not explain to us why the moon and planets move as they do, but it does show us how they move and enable us to calculate their movements. Generations of mathematicians and astronomers have employed large parts of their lives in tracing its consequences in most intricate details, comparing the results with observations, and discerning the past and future history of the solar system. Laplace, perhaps the most illustrious of Newton's followers, says "the number and generality of Newton's discoveries relative to the system of the world, the multitude of original and profound views, which have been the germ of the most brilliant theories of the geometers of the last century, will assure to the 'Principia' a pre-eminence above all other productions of the human intellect."

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[2] Schlesinger, *Publ. Astr. Soc. Pacific*, vol. 14, p. 170.

Newton's Work in Mechanics.[1]

By Prof. Horace Lamb, F.R.S.

If we wish to realise the extent and importance of Newton's contributions to the science of Dynamics, the most obvious way is to compare the long series of propositions contained in the first two books of the "Principia" with the brief record of what had been accomplished by his predecessors and contemporaries. To both he makes ample acknowledgment. Galileo, freeing himself from scholastic tradition, and appealing to experiment as the ultimate test, had ascertained the laws of falling bodies and, assuming the composition of motions, had deduced the parabolic path of a projectile. Considering, further, motion on a smooth incline, he had proved that the velocity acquired from rest must depend only on the vertical height fallen through, and had supported this theoretical result by an ingenious experiment. It is remarkable that this particular result should have been adopted by Huyghens as the basis of his treatment of the cycloidal pendulum instead of the more natural method of resolution of forces, which we should expect. Huyghens, for some reason, seems not to have been satisfied with Galileo's demonstration, and argued that if the theorem did not hold it would be possible for a particle descending one incline and ascending another to pass from rest to rest at a higher level. We have here, of course, a partial apprehension of the principle of energy. His work on the compound pendulum, the first and for a long time the only example of what we call Rigid Dynamics, was based on a similar argument, the assumption here being that a system of particles cannot of itself move from rest in such a way as to raise its centre of gravity. Huyghens, again, had published (without proof) his theorems on centrifugal force, and simultaneously with Wren and Wallis had investigated the laws of collision of bodies. He has the distinction of being mentioned by Newton more than once, with especial respect.

This brief outline embraces, I think, almost all that is important from the point of view of pure Dynamics. The advance in knowledge within a period of little more than half a century was, it is true, remarkable, and still more the changed spirit of investigation, with the ultimate appeal to experiment rather than to *a priori* reasoning. Yet although the laws of motion laid down by Newton were, as he asserts, accepted, particular problems were treated separately, each in a special way. There was no systematic procedure based on general principles by which any given dynamical problem could be reduced to a question of mathematics. For example, no case of a *variable* force was attempted, and indeed the whole theory of curvilinear motion, if we except the parabola of Galileo and the cycloid of Huyghens, was unexplored. The mathematical methods also were rudimentary. The geometrical reasoning of Huyghens, for example, though most ingenious, is special to his problem, and laborious.

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[1] Address delivered on Mar. 19 at Grantham in connexion with the commemoration of the two-hundredth anniversary of the death of Sir Isaac Newton.

When we turn to the "Principia," we find a long array of consequences deduced from the fundamental laws, and by appropriate methods, especially by the consideration of the effect of force on the curvature of an orbit. If we omit from the first eleven sections of the first book a few propositions of mainly geometric interest, and those which are technically astronomical, we find in substance the whole structure of Particle Dynamics much as it is set forth in modern text-books, except for the mathematical methods employed. If we were to reverse what is supposed to have been Newton's procedure and reconvert his geometry into analysis, the result would be a perfectly adequate treatise. This is, in fact, very much what has happened; successive writers have introduced modifications and developments here and there, but the essentials remain the same.

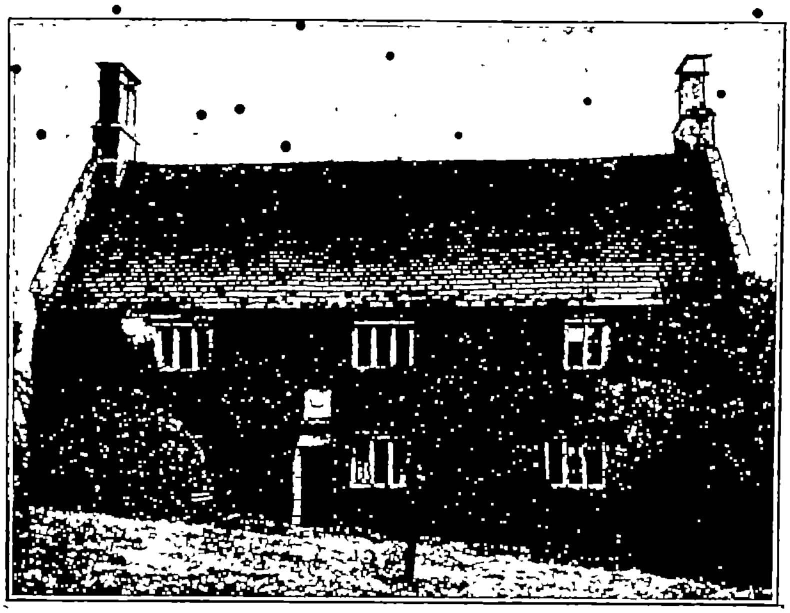
W. Lee] [*Grantham.*

FIG. 6.—Manor House, Woolsthorpe, the birthplace of Newton.

The leading motive which gives a sort of unity to the first book is the law of gravitation with its simpler consequences. We find accordingly the theory of motion in a conic about a focus, the determination of orbits under given conditions, and even a graphical construction for the time in the orbit. The elliptic problem had been put to Newton by Halley, but no one apparently had even thought of the parabolic and hyperbolic cases, though these were to have an astronomical importance. The first step towards a theory of perturbations is made in the theory of revolving orbits, and the calculation of the motion of the apse when the orbit is nearly circular. Next, abandoning the notion of a fixed centre, Newton solves the problem of two bodies subject to their mutual gravitation, with the correction to Kepler's third law. This chain of deductions is brought to a culmination in his celebrated proposition 66, with its long series of corollaries, where the problem of three bodies is attacked in the special form in which it usually presents itself in astronomy. The notion of 'disturbing force,' so fundamental, for example, in the theory of the tides as well as in gravitational astronomy generally, here appears for the first time.

Although the main theme, as has been said, is the law of gravitation, Newton's instinct for generalisation and for mathematical elegance leads him to discuss various collateral questions which incidentally come within the scope of his methods. For example, the whole theory of central orbits under various laws of force is discussed and practically exhausted, except for the interesting case of the inverse-cube, which was left to be completed by Cotes. The law which comes next in importance to the inverse square, namely, that of the direct distance, with the theory of harmonic motion, elliptic and rectilinear, is fully treated. A number of propositions are devoted to various cases of constrained motion, and we meet here with the elegant theorem of the isochronous property of oscillations on an epi- or hypo-cycloid under a central force of this kind. It is, I think, characteristic of Newton, wishing to do things in his own way, that Huyghens' famous result for the ordinary cycloid should be introduced merely as a corollary to this. The first book closes with the theory of attractions of bodies of finite size, including the classical cases of the sphere and spherical shell. Some final propositions on the attractions of stratified media are introduced for their bearing on the corpuscular theory of light.

The second book of the "Principia" deals with a number of questions belonging to the mechanics of fluids, and specially with the theory of resistance. After treating a few standard problems, such as we find in our text-books, on motion under resistances proportional to various functions of the velocity, Newton examines the practical question of how the resistance of the air can be allowed for in pendulum experiments. He has in view here the experimental verification, with as great accuracy as was possible, of his principle that the gravity of a body at a particular place is proportional to its mass. He proceeds to speculate on the nature of the resistance which a fluid opposes to the motion of a body through it. Since this must be due to the momentum communicated to the medium, the law of the square of the velocity is inferred, more or less approximately. Neglecting viscosity, he treats rigorously the case of a medium composed of discrete and inert particles. When he proceeds to continuous fluids such as water, the reasoning is confessedly of a more general character. Incidentally, there occurs a remarkable application of the principle of dynamical similarity, a long anticipation of Fourier.

The remaining propositions deal with hydrostatics and wave-motion. Under the former head we find the law of pressure in an isothermal atmosphere surrounding a globe. Another result, remarkable for the originality of the argument employed, is that if Boyle's law were a statical consequence of repulsive forces between the particles of air, the law of force must be that of the inverse distance. The propositions on waves no doubt owe their insertion to the difficulty which Newton felt in accepting the undulatory theory of light. An ingenious if imperfect attempt is made on the theory of deep-water waves. This is followed by the well-known demonstration of the possibility of sound-waves of harmonic type, and the calculation of their speed of propagation, on the basis of Boyle's law.

From the physical speculations which had attracted some of his contemporaries, Newton carefully refrains. He insists repeatedly that when he refers to accelerating forces or moving forces or centripetal forces he is speaking mathematically, and puts forward no hypothesis as to their ultimate origin. "*Nam virium causas et sedes physicas iam non expendo.*"

This rapid survey necessarily omits much that is interesting. But it should at any rate indicate the enormous debt which the science of Mechanics owes to Newton, for the originality of his conceptions, and for the resolute way in which problem after problem is attacked and made to yield results of interest and beauty as well as of far-reaching importance. It is true, as he indicates, that the fundamental principles had already come to be recognised in a measure, and applied to a few isolated problems. They were now finally vindicated by the host of new and unquestioned results which were shown to flow from them.

Two of the fundamental conceptions were especially due to Newton himself. One is the distinction between gravity and inertia. The other is that of the universal validity of the law of action and reaction, with, in particular, the deduction that the total momentum of a system is unaffected by internal forces. Some appreciation of this is to be found in the work of Huyghens and others on collision, but the generalisation belongs to Newton. A wide extension of the principle is given near the end of the long scholium which he devotes to the explanation and illustration of his third law. It is to be observed that apart from this extension the Newtonian scheme is strictly one of Particle Dynamics, and does not furnish the means of studying in detail the relative motions of the different parts of a solid or fluid of finite dimensions. For this, some additional principle or hypothesis is required, such as was introduced at a later date by d'Alembert and others. It was long overlooked that a sufficient assumption for the purpose is given at the end of the aforesaid scholium. Not only do we find here what is possibly the first general enunciation of the principle of virtual velocities, as distinguished from the partial exemplifications by Galileo and others, but also by the explicit inclusion of accelerating forces the principle becomes identical, when translated into analytical language, with the "variational equation" which Lagrange long afterwards adopted as the basis of his exposition of Dynamics. With this supreme example of the insight of the master this review may fitly close.

Newton's Work in Physics.[1]

By Sir J. J. Thomson, O.M., F.R.S.

THE middle of the seventeenth century, when Newton was born, was remarkable for an outburst in natural philosophy akin to that in literature at the Renaissance. New ideas, new inventions, new discoveries were coming forward both in England and on the Continent. The Royal Society had just been formed to discuss scientific questions and to witness scientific experiments. The soil had been prepared by the work of giants like Descartes, Hooke, Boyle, and Huyghens. To Descartes more than to any one else was this outburst of interest due. It was he who invented the ether; by his theory of vortices he had supplied a consistent and comprehensive theory in which it was conceivable all physical phenomena might find their place and explanation. His theory clothed with romance and fascination the dry bones of science; to see how it fitted into the theory made each new discovery furnish a most fascinating intellectual problem. Later there was much contention between Cartesians and Newtonians, but let us who are Newtonians acknowledge the debt science owes to Descartes, the man whose "Treatise on Geometry" attracted Newton to mathematics and, he said, gave a vaster idea of geometry and the use of algebra than it was possible for him to express or for one who had not read it to imagine.

I am to speak to-day about Newton's work in physics. I will begin by pointing out what is perhaps generally not realised, his skill in the practical as well as the theoretical part of physics. He was an excellent manipulator and experimenter, and liked using his hands. Almost the only recreation in which he seems to have indulged as a boy was to make little work-boxes and trinket cases for his girl friends. He made the first reflecting telescope with his own hands. In the "Optics" he writes about the methods of grinding lenses with a gusto and wealth of detail which show what an old hand he is at the game. When, as in one of the Queries, he discusses chemical questions, he revels in details known only to those who have spent long hours in a chemical laboratory. Mr. Humphrey Newton, who acted as his amanuensis and assistant from 1683 until 1689, says: "At the spring and fall of the leaf he used to employ about six weeks in the laboratory, the fire scarcely going out either night or day, he sitting up one night and I another till he had finished his chemical experiments, in the performance of which he was the most accurate, strict, exact." At this time Newton was working at the transmutation of metals, and I think it exceedingly probable that he had spent more time over this subject than in writing the "Principia."

Newton's great discovery—the splitting up of white light into a spectrum of different colours—was led up to by his seeking for a cause for the bad definition of the refracting telescopes of the time. This was generally attributed to what is called spherical aberration, the rays which pass through the outer parts of the lens not being brought to the same focus as those which pass through the centre; indeed, Descartes had worked out elaborate shapes for lenses in order to remedy this. Newton seems to have convinced himself that there was more in it than this, and was thus led to make his famous experiment. He passed a narrow beam of white light through a prism and found that what had been narrow and white before falling on the prism, after passing through it was spread out into a broad band showing all the colours of the rainbow—red at one end, blue at the other, and between them a gradation of different colours which he divided into seven classes, red, orange, yellow, green, blue, indigo, and violet. He took a narrow beam from this coloured band and let it pass through another prism, and found that it behaved quite differently from the original white beam, and that it was not split up into a broader beam. A narrow beam of red light before falling on the second prism was a narrow beam of red light after passing through it. Again starting with a narrow beam of white light he split it up into a spectrum; he then sent the spectrum through another prism like unto the first but turned the other way up, and reproduced the narrow band of white light again. He first "untwisted the shining robe of day" and then put it together again.

The chapters in the "Optics" where these experiments are described give one, I think, an impression of intellectual power almost unparalleled in the history of physics. Every experiment—nay, almost every sentence—clears up some essential point, and on reading them again a few days ago to refresh my memory, I was even more impressed than I had ever been before, and re-echo the advice of the late Lord Rayleigh, that "*every* student of physics should read the earlier parts of Newton's 'Optics.'"

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[1] Address delivered in King's School, Grantham, on Mar. 19, at the commemoration of the two-hundredth anniversary of the death of Sir Isaac Newton.

It is one of the ironies of science that the outcome of a successful attempt to get at the root of the reason for the imperfections of the refracting telescope should have had the effect of delaying the improvement of that instrument for the best part of a century. Newton diagnosed the disease, but came to the conclusion that it was incurable. As the defect was due to the different coloured rays being differently bent when they passed through a lens, to effect a cure it was necessary to use two lenses, one bending the rays in one direction, the other in the opposite, and to try to adjust the shape and materials of these lenses so that the difference in the bending of, say, the red rays is the same as that of the blue. If the system is to act as a telescope there must be some bending of each of the rays, and this was the difficulty. Newton came to the conclusion that the difference in bending of two rays was always in the same proportion to the average bending whatever the material of the lens. From this it follows that when the difference in bending vanishes the whole bending does so too, so that the system ceases to act as a telescope.

Fig. 7.—Bust of Newton in the Royal Observatory, Greenwich.

I think there were two reasons why Newton came to this conclusion: one was that the prisms he used were either prisms of light glass, or hollow prisms filled with water. He says that he used salt water in these prisms, and it is exceedingly probable that the dispersion of the light glass was almost identical with that of the salt water. There was, however, another reason which in my opinion was the one that influenced him most. Most of us, I think, on looking at the spectrum, would suppose that the number of colours to be distinguished is rather a question of the number of names our language supplies for different colours than of anything else. I do not think Newton held that opinion. He seems to have regarded the different colours—red, orange, yellow, green, blue, indigo, and violet as, so to speak, different genera and the light inside these colours as different species; he therefore attaches great importance to the places where one of these colours begins and the other ends. As "his own eyes are not very critical in distinguishing colour," he got a friend to measure the length of the different coloured spaces.

Now, unfortunately, the divisions between the different colours given by these measurements turned out to be in the same proportion as a string is divided between the end and the middle to give the divisions of the octave on the diatonic scale. Thus if the length of the string giving the lowest note is 1, and the length of the spectrum ½, the length of the string giving the octave will be at the end of the violet, the length of the string giving the note next to the octave will be at the junction of the indigo and violet, the next at the junction of the indigo and blue, and so on. I think Newton was profoundly influenced by this view: he returns to it in his work on the colours of thin plates, and shows that the thicknesses of the plates which give the junction colours are proportional to the cube roots of the squares of the length of these chords on the diatonic scale. As on this view the widths of the different colours are always in fixed numerical ratios, the spectrum given by one substance will be exactly similar to that given by another; this means that the dispersion of all substances is the same and that an achromatic combination is impossible. It was, I think, the siren's song of these harmonics that lured Newton to this false conclusion. We must remember that Newton had no suspicion that the spectrum as he saw it, beginning at the red and ending at the violet, was not a complete entity, or that there was anything on either side of it; we know now that the visible spectrum is but a more or less arbitrary piece of a much larger structure.

It was, too, a very prevalent belief that these harmonics were the key to many of the mysteries of Nature. Kepler, for example, spent many years' work trying to express the motion of the different planets in terms of these harmonics. Holding these views, Newton came to the conclusion that the chance of making a refracting telescope was desperate; he abandoned what he called his glass work and devoted himself to developing the reflecting telescope. He was the first to construct such a telescope, though Gregory had provided him with a design for one on somewhat different lines. It is a remarkable illustration of Newton's influence on the science of his time, and for long after, that his error about achromatism was not corrected for more than fifty years, and that when at last this was done, it was due to the independent researches of two practical men, one a country gentleman and the other an instrument maker, and not to a philosopher attached to any seat of learning.

Newton next applied himself to the study of the colours of thin films, such as soap bubbles, and thin pieces of mica. These had previously been studied by Hooke and Boyle, and Hooke had published a theory of them in a paper which is one of the most remarkable in the history of optics; in it he foreshadows the principle of interference, and Young, the discoverer of this principle a century later, said that a knowledge of this paper would have materially hastened the discovery. The observations of Hooke and Boyle were entirely qualitative. Newton, as was his wont, reduced everything to definite numbers. His extraordinary powers of observation, and his genius for reducing to a few fundamental principles a mass of confused and perplexing phenomena, were never more conspicuous than in this investigation. The subject, which before he began his work had been but a medley of facts without any apparent connexion, was reduced by him to law and order; so much so that even now there are few better or clearer accounts of the fundamental phenomena, apart from their explanation, than that given in the "Optics." Surprisingly few of the great number of effects shown by these thin films escaped Newton's notice. He discovered the law connecting the thickness of the film with the colour it shows; he gives us the first measure of a quantity akin to the one we call now the wave-length of the light. He supposes that a ray of light as it travels through space alternates between two moods; when in one of these moods it falls on a surface it is reflected, when in the other it is transmitted. Each mood lasts while the ray travels a certain distance, and the ray is supposed to be always in one or other of the moods. He calls these moods 'fits' of easy transmission and reflection, and the quantity he measured is the space passed over by light on the duration of one of these fits. He deduced from his work a scale of colour by which a colour was classified by the thickness of the plate which gave rise to it. His great powers of observation were shown in the discovery of what are known as the colours of thick plates, which generally require some finding even when one knows where to look for them. He showed, too, that solar and lunar haloes were due to the presence of minute drops of water all of the same size.

Newton's experiments on thin plates so impressed him with their possibilities for the production of colours that he brought forward a theory of colour in which he supposes that the colours of all natural bodies, even coloured solutions such as wine, arise in this way. He supposes that the smallest particles of bodies are transparent and would be colourless if alone. When, however, they congregate together, as in solids and liquids and to some extent in gases, their parts are separated by interstices, and a rough description of his theory is that the colour of a body is that of a thin plate the thickness of which is equal to the interstice. Newton, though he had an accurate idea of the scale of the structure of light, very much over-estimated the coarseness of the structure of matter. He says in his "Optics" that if we could make microscopes to magnify some 5000 times, we could probably detect these interstices. He thought that the interstices were of the same order as the length of a 'fit' of easy transmission or reflection, whereas we know that they are less than 1/1000 of that distance, much too small to be of any use for Newton's theory.

Another ingenious application of the colour of thin plates was his explanation of the blue colour of the sky. He supposes that it is due to minute bubbles of water in the air, and that the bubbles are thin enough to make the blue predominate. This theory lasted until comparatively recently, when the late Lord Rayleigh showed that a quite distinct though in some respects analogous effect, the scattering of light by small particles in the air, gave an explanation more in accordance with the facts.

I now turn to the question of Newton's views as to the nature of light. Newton was always exceedingly careful not to tie himself down to any precise specification of the structure of light. He would not, I think, have accepted as a correct representation of his views the theory that was fathered upon him by his successors, that light consisted of small material particles and nothing else. We have in the letters to Hooke and Boyle a record of the ideas about light which were passing through his mind when he was busiest with his optical researches, and we find that then the ether was an integral part of his conception of light. He says: "Were I to propound an hypothesis it should be this, that light is something capable of exciting vibrations in the ether." He gives, however, his reasons for thinking that there must be something besides these vibrations, and gives a long list of alternatives.

> "They that will may suppose it an aggregate of various peripatetic qualities. Others may suppose it multitudes of unimaginable small and swift corpuscles of various sizes springing from shining bodies. . . . But they that like not this may suppose light any other corporeal emanation, or any impulse or motion of any other medium or etherial spirit diffused through the main body of aether or what else they may imagine proper for their purpose. To avoid dispute and make this hypothesis general, let every man here take his fancy, only whatever light be I suppose it consists of rays differing from one another in contingent circumstances as bigness from vigour."

Again, in his letter referring to Hooke's undulating theory he says: "The hypothesis of light being a body, had I propounded it, has a much greater affinity with the objector's own hypothesis than he seems to be aware of, the vibrations of the aether being as useful and necessary in this as in his."

In the "Optics," published thirty years later, which begins: "My design in this book is not to explain the properties of Light by Hypothesis, but to propose and prove them by reason and experiment," the ether is not introduced into the body of the book. The idea of 'fits' of easy transmission and reflection is sufficient for his purpose; he just postulates the existence of these 'fits,' saying: "I content myself with the bare discovery that the rays of light are by some cause or other alternately disposed to be reflected or refracted through many vicissitudes." But if the ether is banished from the three books of the "Optics" it appears in full vigour in Query 29. Newton says:

> "Are not the rays of light very small bodies emitted from shining substances? Nothing more is requisite for putting the Rays of Light into Fits of easy Reflection and easy Transmission than that they be small bodies which by their attractive power or some other Force, stir up Vibrations in what they act upon, which Vibrations being swifter than the Rays overtake them successively and agitate them so as by turns to increase and decrease their velocities and thereby put them into those Fits."

Thus Newton regarded light as possessing a dual structure, one part of which was the small corpuscle, the other the vibrations which surround it. One very important feature of Newton's theory of light, and one which differentiates it very sharply from the undulatory theory, is that on Newton's theory the structure of light is essentially atomic; it is made up of discrete and definite parts. He says in his first definition, "By the rays of light I understand its least parts." He regards light as made up of those parts which travel through space unchanged; the light coming to us from a star is made up of particles of exactly the same kind as those in the light as the star itself; the only difference is that the particles get more and more widely separated, as the distance from the star increases.

Let me illustrate the difference between this result and that which obtains on the undulatory theory by the consideration of the following case. Suppose we have a battery of guns in action. The guns emit both shot and waves of sound; as we go farther from the guns our chance of being hit by the shot gets smaller, but if we are not so far away that the shot has lost speed, the effect when we are hit is just as bad as if we were nearer to the guns; the effect of increasing the distance is to diminish the number of casualties without changing their character. Now consider the sound waves. Let us call the striking of these waves against our ears a casualty; also when we go to a greater distance the chance of these continuous waves hitting us will be just as great as when we are nearer in, but the noise will fall away quickly as the distance increases. In this case the number of casualties will not diminish with the distance but their character will change. This is a fundamental difference between a corpuscular and an undulatory theory.

In recent years great attention has been paid to the electrical effects produced by light; one of these is the emission of electrons from a metal surface when light falls upon it. The number and velocity of these electrons can be measured with considerable accuracy. It has been found that, as the distance of the metal from the source of light increases, the number of electrons emitted decreases; that is, the number of casualties diminishes, but those electrons which are emitted are moving just as fast as when the metal was close to the source of light: that is, the character of the casualties is not changed. This is but one of many of the electrical effects produced by light which show the same characteristic. In fact, all these effects indicate that the structure of light must be atomic rather than continuous. If we confine ourselves to the corpuscles, though we might explain the electrical effects we could not explain the optical phenomena of interference; but we must remember that Newton in his confidential moods never contemplates the corpuscle as being the sole constituent of his units. These were always accompanied by vibrations in the ether, and the effect of these as well as the corpuscles must be taken into account.

At the end of the "Optics," come the Queries. In these Newton abandons the severe, almost Euclidean, style of the earlier part of the book; he flings away his policy of "hypotheses non fingo"; he makes up for lost time. The suggestions he makes are extraordinarily acute and suggestive. Here is one of them.

> "Are not gross bodies and light convertible into one another and may not Bodies receive much of their activity from the particles of Light which enter into their composition. The changing of bodies into Light and Light into Bodies is very conformable to the course of Nature which seems delighted with transmutations."

In another Query Newton connects the abnormal refracting powers of some substances with their chemical nature, a subject which is now of great importance. The connexion he suggests is that since these bodies are so affected by light, their chemical nature is such as to make them readily take fire and emit light for themselves. This is the first and most daring of reciprocal relations of the type we are now familiar with in thermodynamics.

Newton suggests that the ether in itself is atomic and that the atoms may not all be of one size. He calculates from the rise of liquid between two glass plates the force exerted by the attraction of the particles of the glass on water at a distance of ⅛ of one hundred thousandth part of an inch, that is, about one millionth of a centimetre, and finds it sufficient to hold up a cylinder of water two or three furlongs in length. He has extraordinary clear and definite ideas about chemical combination much in advance of anything which appeared for more than a century afterwards.

I have confined myself to Newton's work on optics. I have not time to do more than recall that he was the first to give the theory of the propagation of waves of sound. His work in physics is but a part, and perhaps not the most important part, of his scientific work, but if it stood alone his would still be one of the great names in science.

Newton's Work in Pure Mathematics.[1]

By Prof. L. J. Mordell, F.R.S.

When we consider the numerous and wonderful developments of mathematics since the beginning of the last century, it is very difficult for us to appreciate the state of mathematics just before the rise of Newton. The period was a critical one in the history of this science. All the signs pointed to a great awakening, and the world was ripe for important and far-reaching discoveries. This was the time of the last days of Fermat (1601–1665) and of Descartes (1596–1650), who had both initiated epoch-making discoveries. From the modern point of view, what little was known related to geometry, trigonometry, algebra, and the theory of equations. Their fundamental principles had been laid down roughly in the form in which they are now familiar to elementary students. General theorems were extremely scarce. Each new differential property of a curve, each new expansion of a function of x, required new methods. Mathematics was chiefly a collection of isolated theorems and examples.

Many distinguished mathematicians have shown unmistakable signs of mathematical genius at an early age. Newton, however, knew no mathematics when he entered Trinity College in 1661 at nineteen years of age. He was introduced to mathematics in his first term by the purchase of a book on astrology, which he could not understand because of the references to geometry and trigonometry. He then started to study Euclid's geometry, which he found very easy and almost obvious. He followed with a book on arithmetic and Descarte's "Géométrie," which was difficult enough to interest him. As an undergraduate he also read the works of Vieta, Van Schooten, and Wallis.

Newton's original investigations were commenced early in his career. In a manuscript of his written in 1665, the year in which he took his B.A. degree, there is the earliest documentary proof of his invention of the fluxional calculus, that is, what is now called the infinitesimal calculus. He had worked this out fairly completely and had applied it to finding tangents, radii of curvature, etc., of curves. It also led him to the discovery of the binomial theorem.

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[1] Address delivered in King's School, Grantham, on Mar 19, at the commemoration of the two-hundredth anniversary of the death of Sir Isaac Newton.

It is given to very few people, even in their later years when their powers have fully matured, to make so fundamental, so brilliant, so epoch-making a discovery as the invention of the calculus. Thus it is all the more marvellous that Newton should have done so in his early manhood after so short a period of study. His discovery represented the second stage in the emancipation of mathematical ideas from the bondage in which they seem to have been held since the time of the ancient Greeks. The first stage was due to Descartes and his system of analytical geometry.

Newton's discovery meant in those days even more than Cauchy's theory of the complex variable meant in his. It seemed to unlock the gates guarding the storehouse of mathematical treasures; to lay the mathematical world at the feet of Newton and his followers; to open up new paths, new regions that would require years to develop.

It is uncertain how far Newton developed his calculus or what were the dates of his discoveries, as he was very reluctant to publish his results. Many of his most important discoveries had their origin in problems arising from the calculus. Others, especially in geometry, arose from his endeavour to put the proofs of theorems of applied mathematics in a form free from the calculus, which appeared to be greatly distrusted for years after its invention because of the logical difficulties encountered by the mathematicians and philosophers who took up its study.

The question of integration was one of the most fertile sources of Newton's results. Thus in 1676, in letters to Oldenburg, the secretary of the Royal Society, who had been corresponding with Leibniz about some of the latter's results, Newton describes some of his own work and some of his methods of discovery, and in particular of the binomial theorem.

The binomial theorem was discovered in finding the integral of $(1-x^2)^{\frac{1}{2}}$. Newton noted that

$$\int(1-x^2)dx=x-\frac{x^3}{3},$$

$$\int(1-x^2)^2dx=x-\frac{2x^3}{3}+\frac{x^5}{5},$$

$$\int(1-x^2)^3dx=x-\frac{3x^3}{3}+\frac{3x^5}{5}-\frac{x^7}{7}.$$

He studied the forms of the coefficients, and induction suggested to him the result

$$\int(1-x^2)^{\frac{1}{2}}dx=x-\frac{\frac{1}{2}}{3}x^3+\frac{\frac{1}{2}\cdot\frac{1}{2}-1}{2!}\frac{x^5}{5}$$
$$-\frac{\frac{1}{2}\cdot\frac{1}{2}-1\cdot\frac{1}{2}-2}{3!}\frac{x^7}{7}\cdots$$

He then deduced the binomial expansion for $(1-x^2)^{\frac{1}{2}}$, which he verified by squaring and showing that the result reduced to $1-x^2$. He then gave without proof the expansion of $(a+b)^n$ as an infinite series. It was only after many years that a satisfactory proof was obtained by Abel. Newton realised that infinite series should be convergent, but did not know any tests for convergency. The present-day student would consider it an easy matter to find inductively the well-known expansion of $(1+x)^n$. It comes rather as a shock to realise that the winning of the simple, elementary mathematics of to-day required mighty geniuses at some time or other.

Newton also gave in this letter the expansion of $\sin^{-1} x$. He deduced from this the expansion of $\sin x$ by the method of reversion of series, the earliest example of this process. History was to repeat itself many years afterward when the expansions of elliptic integrals were to precede those of elliptic functions. He also found the length of an arc of an ellipse by infinite series. He evaluated the binomial integral

$$\int x^m(b+cx^n)^p dx,$$

which can be integrated in finite terms if $(m+1)/n$ is a positive integer, and which he thought, erroneously, could not be done otherwise without infinite series. In later years, he also solved the problems of orthogonal trajectories and of the brachistochrone. He solved differential equations by the use of infinite series, and, as he says, any differential equation can be integrated in this way. But this of course does not end the matter.

Very little need be said about the discussion which raged for so many years as to whether Newton or Leibniz deserved priority in the invention of the calculus. It is now considered that they were independent discoverers. This is not really surprising when the work and interests of the mathematicians of their era are considered. The history of mathematics abounds with similar examples. The theory of elliptic functions was discovered independently by Abel and Jacobi, and it was only many years after the death of Gauss that his notebooks revealed that he had anticipated both of the others, but had not published his work.

Newton lectured on algebra and the theory of equations during the years 1673–1683, and many theorems on these subjects are now associated with his name. The reversion of series has already been mentioned. Another very important theorem, now fundamental in the theory of algebraic functions of a variable, is referred to as Newton's parallelogram. It discusses the shape of a curve with a multiple point at the origin or at infinity and is equivalent to finding, from a given relation $F(x, y) = 0$ the initial terms in the expansion

$$y = Ax^{\frac{r}{s}} + Bx^{\frac{r}{s}} + \ldots .$$

The calculus also led him to the method of interpolation. By this he approximated to the shape of a curve by drawing a higher parabolic curve

$$y = a + bx + cx^2 + dx^3 + \ldots$$

through a number of points on the given curve. He was thus enabled to find the area approximately by easy integration.

Newton left his impress particularly upon the theory of equations. He proved that imaginary roots occurred in pairs. It may be recalled that it was only in the nineteenth century that the importance of imaginary numbers was appreciated and fully understood. His formula for the lower limit to the number of imaginary roots in an equation was given without either proof or any indication of the method by which he discovered it. It remained for Sylvester to prove in 1865. Newton laid the foundation for the theory of the symmetrical function of the roots of an equation by giving his well-known formula for the sum of the nth powers of the roots in terms of the coefficients of the equation.

Newton's name has been given to a method for finding approximately the root of an equation. In the form in which it is now used, namely, that if a is an approximation to a root of the equation $f(x) = 0$, then

$$a - \frac{f(a)}{f'(a)}$$

is in general a better approximation, the theorem is not due to Newton but to Raphson.

Newton's method as exemplified by his famous cubic

$$y^3 - 2y - 5 = 0$$

was to put

$$y = 2 + p,$$

so that the equation becomes

$$p^3 + 6p^2 + 10p - 1 = 0.$$

Neglecting the higher powers of p, he gets $10p = 1$. He then puts

$$p = 0{\cdot}1 + q$$

in the equation for p and gets

$$q^3 + 6{\cdot}3q^2 + 11{\cdot}23q + 0{\cdot}061 = 0.$$

The approximate value of q is given by

$$11{\cdot}23q + 0{\cdot}061 = 0.$$

He then puts

$$q = -0{\cdot}0054 + r,$$

etc.

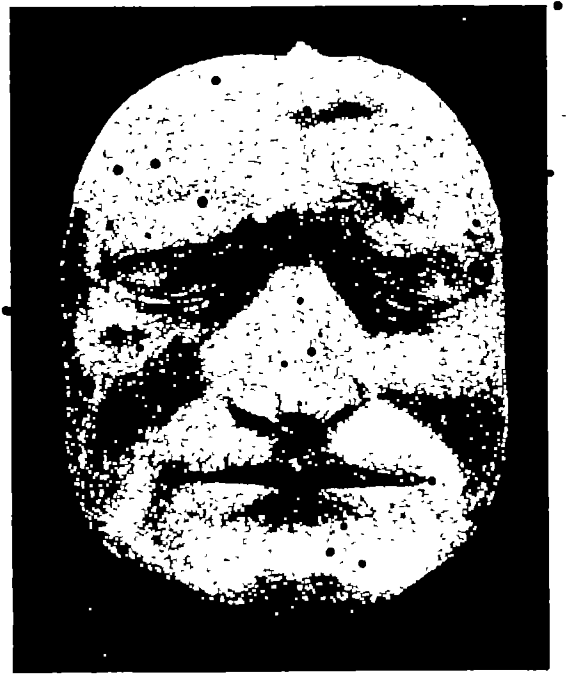

FIG. 8.—Cast of Newton's face, in the possession of the Royal Society, London.

From Green's "Short History of the English People"

We come finally to the geometrical work of Newton. He was unequalled by modern writers in his power in the use of the methods of classical geometry, though he discovered no new principles. The geometrical solution of the problem of Pappus, to find the locus of a point such that the rectangle contained by its distances from two given lines shall be in a given ratio to the rectangle contained by its distances from two other given lines, had baffled the efforts of geometers since the time of Apollonius. Newton apparently gave without much difficulty an elegant proof that the locus was a conic.

Equally skilful was Newton in the application of analytical geometry to the theory of curves. He distinguished between algebraic and transcendental curves, and showed that the former were cut by a straight line in a number of points given by the degree of the equation, and the latter in an infinite number of points. This, of course, is a fundamental theorem in geometry.

Newton investigated the properties of cubic curves analogous to those of conics such as asymptotes and diameters. He then proceeded to reduce the equation of a cubic to four simple canonical forms. Each of these was discussed in detail, and its double points, ovals, etc., were considered. He found seventy-two of the possible seventy-eight forms that a cubic may take. Finally, he stated without proof that all cubic curves could be derived by projection from the canonical form

$$y^2 = ax^3 + bx^2 + cx + d,$$

a theorem which remained unproved until 1731. Apart perhaps from some of his geometrical investigations, Newton's pure mathematics was dominated by his invention of the calculus and his efforts to solve the problems of Nature. No one has surpassed him in combining theory and its application. No one appreciated him more than the greatest of the great mathematicians.

Newton's Work in Optics.

By Sir Richard Glazebrook, K.C.B., For. Sec. R.S.

NEWTON entered Trinity College, Cambridge, in 1661 shortly before his nineteenth birthday, and proceeded to his B.A. degree in 1665. On Oct. 1, 1667, he became a fellow of the College, and in 1669 was chosen as Lucasian professor of mathematics in succession to Barrow, whose optical lectures he had helped to edit during the previous year. His own interest in optics began at an early date; while still an undergraduate he had written about haloes. In 1666 he "procured a triangular glass prism to try the celebrated phenomena of colours." His first telescope was constructed in 1668 and his second telescope sent to the Royal Society in 1671. The following year (Jan. 11, 1671, old style) he was elected a fellow of the Royal Society, and his letter containing his new theory of light and colours was read on Feb. 6, 1672. Hooke, who with Boyle and the Bishop of Salisbury was asked to report on the paper, wrote a critical report, claiming that Newton's results were contained in his own "Micrographia" published in 1664. Criticisms were also published by Linus of Liège and Lucas.

Newton was admitted as a fellow of the Royal Society in 1675, and shortly afterwards sent to the Society a paper on the colours of thin plates. Hooke was again a critic. The main part of the work, he said, "was contained in the 'Micrographia,' which Mr. Newton had only carried further in some particulars."

Some correspondence followed, and Newton in his final letter gave Hooke full credit for his work. "You," he wrote, "have added much several ways, and specially in considering the colours of thin plates. If I have seen farther it is by standing on the shoulders of giants."

It was not until some thirty years later (1704) that the first edition of the "Optics" appeared. A second edition with additions—"A Treatise," it is called, "of the Reflexions, Refractions, Inflexions, and Colours of Light"—was printed by the printers to the Royal Society in 1718, fifty years after the construction of his first telescope, and contains, in a series of Queries of very real interest, his latest views on optics and allied subjects.

But before dealing with the questions raised in these, some reference to the book itself is called for. The difficulties which followed the reading of his papers in 1675 were the main cause of the delay in publication. "To avoid being engaged in Disputes about these Matters," he writes, "I have hitherto delayed the printing, and should still have delayed it had not the Importunity of Friends prevailed upon me." The treatise is divided into three books. The first deals with the reflexion, refraction, and dispersion of light; the second with the colours of thin and thick plates; and the third with diffraction, and in the Queries with double refraction and the theory of light.

The first book opens with a statement of known propositions as a series of definitions and axioms. "For what hath hitherto been generally agreed on I content myself to assume under the Notion of Principles. . . . And this may suffice for an Introduction to Readers of quick Wit and good Understanding not yet versed in Optics, although those who are already acquainted with this Science and have handled Glasses will more readily apprehend what followeth," and then we come to Prop. I. Theor. I. "Lights which differ in Colour differ also in Degrees of Refrangibility." From this we pass by a series of experiments most beautifully designed, most clearly described, to an investigation of the chromatic aberration of lenses with an account of the defects of refracting telescopes, incurable, as Newton thought he had proved it to be by these experiments, and the construction of his own reflecting instrument. "Seeing, therefore," he writes, "that the Improvement of Telescopes of given lengths by Refractions is desperate, I contrived therefore a Perspective by Reflexion, using instead of an Object-glass a concave Metal." The mirrors of the first two telescopes he made and polished himself.

"By many trials I learnt the way of polishing till I made those two reflecting Perspectives. . . .

For this Art of polishing will be better learned by repeated Practice than by my Description."

"When I made these an Artist in London undertook to imitate it, but using another way of polishing them than I did he fell much short of what I had attained to, as I afterwards understood by discoursing the under Workman he had employed."

Newton was mistaken, as we now know. Fig. 9—Fig. 26, Plate V., of the first book of the "Optics"—illustrates the crucial experiment (Exp. 15, Bk. I. Part I.). In the figure PT is the position of the spectrum formed on a vertical screen by a prism with its edge horizontal and its angle downwards. The plane of the screen is parallel to the edge of the prism. The light forming this spectrum is intercepted by a second prism placed close behind the first, but with its edge vertical; the spectrum is displaced into the position pt. Tt and Pp measure the tangents of the deviation of the violet and red ends respectively, while their difference depends on the dispersion. $2t2p$ and $3t3p$ represent spectra formed similarly by other prisms placed in turn in the position of the first vertical prisms. S is the position of the spot formed on the screen by the direct light of the sun, painting "his round white image when the prisms were taken away."

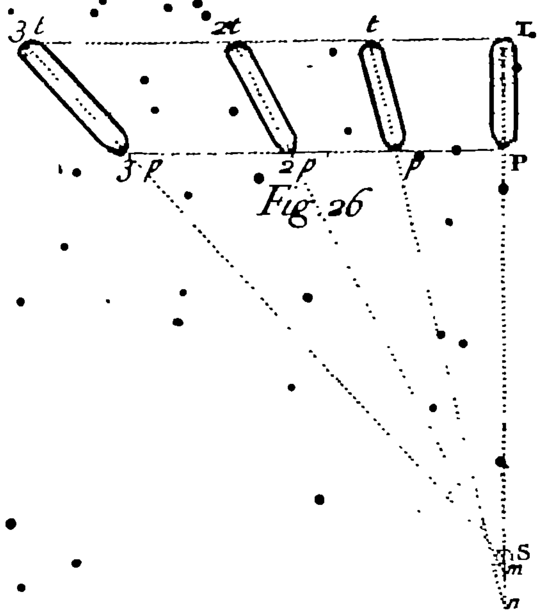

FIG. 9.—Reproduced from Newton's "Optics."

Newton observed that when the angle of the prism forming the image $3p3t$ was equal to that of the first prism, the axis of the spectrum $3t3p$ met that of the original spectrum TP at the centre of the sun's image S, while the produced axes of the spectra tp or $2t2p$ formed by prisms of less angle cut the axis of TP in the points m, n a little beyond the centre of the image S. From the figure he obtained the values of the tangents of the deviations of the violet and red rays in each case

"from whence the Proportions of the Sines being derived, they come out equal so far as by viewing the Spectrums and using some mathematical Reasoning I could estimate";

or, in other words, if we denote by α, β, the deviations of two rays (violet and red, say) produced by a prism, then the ratio $\sin\alpha/\sin\beta$ is independent of the prism.

It is, however, not clear from the description that the prisms were of different material. With modern glasses of high or moderate dispersion the axes of the spectra would not be straight, but curved, and would not appear to meet near S.

Newton refers to the different angles of the several prisms, and continues:

"But for want of solid Glass Prisms with Angles of convenient bignesses, there may be Vessels made of polished plates of Glass cemented together in the form of Prisms and filled with Water."

It is at any rate possible, or perhaps rather probable, that he proved the proposition only in the case of prisms of the same material, and in any case it is not likely that he used prisms of widely different optical properties, even though they may not all have been bought at Stourbridge Fair, to try the celebrated phenomena of colours. And so he concludes:

"But by reason of this different Refrangibility I do not see any other means of improving Telescopes by Refractions alone than that of increasing their lengths, for which end the late Contrivance of Hugenius seems well accommodated."

But to pass on; other propositions of the book deal with the nature of white light and the composition of colours.

"Colours," it is shown, "may be produced by Composition which shall be like to the Colours of Homogenial Light as to the appearance of Colour, but not as to Immutability of Colour and Constitution of Light";

and again:

"Whiteness, and all grey Colours between white and black, may be compounded of Colours, and the whiteness of the Sun's Light is compounded of all the primary Colours mixed in a due Proportion."

In another proposition it is shown that if light be due to the motion of corpuscles moving in the direction of the ray, but subject, when in the neighbourhood of the surface of separation of two different media, to a force normal to the surface, and if v, v' be the velocities in the two media, ϕ, ϕ' the angles of incidence and refraction, then $\sin\phi/\sin\phi' = v'/v$. Thus if ϕ is $> \phi'$, then v' is $> v$, or, of the two media, the velocity is greater in the more dense, contrary to what we now know to be true.

So far Newton has been dealing with geometrical optics. Book II. introduces us to "Observations concerning the Reflexions, Refractions, and Colours of thin transparent Bodies"—to Newton's rings and the theory of light he devised to account for his observations.

Hooke in 1665, and Boyle two years earlier, had observed the colours shown by thin sheets of mica in both transmitted and reflected light, and Hooke ("Micrographia," p. 47) had described how to produce these colours by placing two lenses in contact and reflecting light from the thin film of air between them. Newton, after a brief reference to the observations of others, describes his own experiments. He found the squares of the radii of the bright rings to be in the arithmetical progression of the odd numbers 1, 3, 5, . . . and those of the dark rings in the arithmetrical progression of the even numbers 0, 2, 4, 6, ...

A knowledge of the radii of curvature of the lenses and of the radii of the rings enabled him to calculate the thicknesses of the air film for light and dark rings. These he found to be, in inches, 1/178000, 3/178000, . . . and 0, 2/178000, 4/178000 . . . . respectively.

Having now obtained his facts, Newton attempts to explain them:

> "Every Ray of Light," he writes (Bk. II. Pt. iii. Prop. xii.), "in its passage through any refracting Surface is put into a certain transient Constitution or State which in the progress of the Ray returns at equal Intervals and disposes the Ray at every return to be easily transmitted through the next refracting Surface, and between the returns to be easily reflected by it." And then follows a definition: "The returns of the disposition of any Ray to be reflected I will call its Fits of easy Reflexion, and those of its disposition to be transmitted its Fits of easy Transmission, and the space it passes between every return and the next return the Interval of its Fits."

He has no theory to account for this, but writes:

> "What kind of action or disposition this is; whether it consists in a circulating or a vibrating Motion of the Ray or of the Medium or something else, I do not enquire."

He postulates (Query 17) a refracting or reflecting medium in which waves of vibration or tremors are excited at a point in which a ray of light is incident, "and continue to arise there and be propagated from thence as long as they continue to do so." While (Query 18) he writes, after describing an experiment which shows that heat can reach a thermometer when suspended in a vacuum:

> "Is not the Heat of the warm Room conveyed through the *Vacuum* by the Vibrations of a much subtiler Medium than Air, which after the Air was drawn out remained in the *Vacuum*? And is not this Medium the same with that Medium by which Light is refracted and reflected, and by whose Vibrations Light communicates Heat to Bodies and is put into Fits of easy Reflection and easy Transmission? And do not the Vibrations of this Medium in hot Bodies contribute to the intenseness and duration of their Heat, and do not Hot Bodies communicate their Heat to contiguous cold ones? And is not this Medium exceedingly more rare and subtile than the Air, and exceedingly more elastick and active? And doth it not readily pervade all Bodies? And is it not (by its elastick force) expanded through all the Heavens?"

And again, Query 19:

> "Doth not the Refraction of Light proceed from the different density of this Ethereal Medium in different places, the Light receding always from the denser parts of the Medium? And is not the density thereof greater in free and open Spaces void of Air and other grosser Bodies than within the Pores of Water, Glass, Crystal, Gems, and other compact Bodies?"

These queries appeared in 1718. In the text of the "Optics" (1704), Newton was more cautious, for in Prop. xii., after his inquiry as to the action or disposition which causes the alternate fits of reflexion and transmission, he permits "those who are averse from assenting to any new Discoveries but such as they can explain by an Hypothesis" to "suppose for the present" that "the Rays of Light by impinging on any refracting or reflecting Surface, excite vibrations in the reflecting or refracting Medium or Substance."

We will return below to the question of why this complexity was necessary.—A stream of corpuscles constituting a beam of light, accompanied in their path by waves in an elastic medium travelling with a velocity exceeding that of the corpuscles themselves, overtaking them and jostling them into alternate fits of reflexions and transmission, a theory so complex that in the words of Verdet:

> "Pour renverser ce pénible échafaudage d'hypothèses indépendantes les unes et les autres il suffit presque de le regarder en face et de chercher à le comprendre."

Meanwhile some brief account must be given of the Third Book of Optics: "Observations concerning the Inflexions of the Rays of Light and the Colours made thereby." It deals with Grimaldi's observation of the colours of bands seen on either side of the shadow of a hair illuminated by light from a small hole—the diffraction of light.

Newton experimented with sunlight transmitted into his darkened chamber through a pinhole $\frac{1}{42}$ part of an inch in diameter. "For 21 of those Pins laid together took up the breadth of half an inch"; he measured the breadth of the fringes, three in number, at various distances from the hair, and extended the observations to include the fringes produced by a sharp knife edge and also by a narrow triangular slit formed by two knife edges inclined at a small angle to each other. Of these appearances he attempts no explanation, stating that at the time he was interrupted, "and cannot now (1718) think of taking these things into consideration. And since I have not finished this part of my Design, I shall conclude with proposing only some Queries in order to a further search to be made by others," and the first queries ask:

"Do not Bodies act upon Light at a distance and by their action bend its Rays, and is not this action (*cæteris paribus*) strongest at the least distance? Do not Rays which differ in Refrangibility differ also in Flexibility? Are not Rays of Light in passing by the edges and sides of Bodies bent several times backwards and forwards; with a motion like that of an Eel? And do not the three fringes of coloured Light above mentioned arise from three such bendings?"

In Query 25 we come to the double "refraction of Island Crystal described first by (1670) Erasmus Bartoline and afterwards more exactly by Hugenius in his book 'de la Lumiére' (1690)." The properties of the crystal and its effects on light are described, ending with the Query (26):

"Have not the Rays of Light several sides endued with several original Properties?"

Stearn] [Cambridge.

FIG. 10.—Statue by Roubiliac in the ante-Chapel of Trinity College, Cambridge, given to the College by Dr. Robert Smith, Master, 1742–68.

This is discussed and proved, leading to a further Query (28):

"Are not all Hypotheses erroneous in which Light is supposed to consist in Pression or Motion propagated through a fluid Medium? . . . for Pression or Motion cannot be propagated in a Fluid in right Lines beyond an Obstacle which stops part of the Motion, but will bend and spread every way into the quiescent Medium, which lies beyond the obstacle?"

As a further objection he writes, after a reference to Huyghens' experiments on polarisation:

"For Pressions or Motions, propagated from a shining Body through an uniform Medium, must be on all sides alike; whereas by those Experiments it appears that the Rays of Light have different Properties in their different Sides."

Thus Newton is led to the conclusion expressed in Query 29:

"Are not the Rays of Light very small Bodies emitted from shining Substances? For such Bodies will pass through uniform Mediums in right Lines without bending into the Shadow which is the Nature of the Rays of Light."

In 1675 he had been less positive; in his series of

"Hypotheses as to the Nature of Light," submitted in that year to the Royal Society, he wrote, after premising the existence of an ether in which waves were set up by the impact of light rays on a reflecting or refracting surface:

> "In the fourth place therefore I suppose light is neither æther nor its vibrating movement, but something of a different kind propagated from lucid bodies. To avoid dispute and make this hypothesis general let every man take his fancy. Fifthly, it is to be supposed that light and æther mutually act upon one another."

Newton was aware of Huyghens' "Traité de la Lumière," with its beautiful construction for determining the position at any instant of a wave front, in a medium either crystalline or isotropic, as the envelope of the wavelets proceeding from all points of a previous position of the front; but such a construction did not account for rectilinear propagation. He was aware, also, of the fact that two waves in water of the same period reaching a given point by paths differing by an odd multiple of half a wave produced rest, and had thus explained the tidal phenomena of the port of Batcha in Cochin China, an explanation which one hundred years later first put Young on the track of interference; but he failed to see how this would account for many of the experimental results he had so clearly described.

Newton knew, also, that sound waves in air were propagated by disturbances taking place in the direction in which the waves are travelling, and, for him and his contemporaries, the waves in the luminiferous medium possessed this same property. Such a motion could not account for polarisation, and though he refers several times in the "Optics" to the vibrations of a stretched string, no one in his day had conceived that the vibrations to which light is due could, like those of the string, be transverse and give to the ray the sides needed to account for polarisation.

A century passed before Newton's doubts were resolved, and for that period his views held the field until, on Nov. 12, 1801, Young applied the principle of interference to explain the diffraction of light, the colours of thin plates, and many of the other phenomena discussed by Newton. Fresnel's first memoir on diffraction is dated 1815, and was followed in rapid succession by other researches by which he established securely the consequences of interference, and showed how it, when combined with the extreme smallness of the wave-length of light, led to an explanation of the rectilinear propagation. His memoir on the diffraction of light was crowned by the French Academy in 1818, exactly a century after the publication of the second edition of the "Optics."

Newton's second difficulty was solved at the same time. Hooke had suggested, but without any convincing reasons, that the vibrations in a light ray were transverse to the ray. Fresnel in 1816, in a Memoir on the influence of polarisation on the mutual action between two rays of light, makes the same hypothesis. Young in 1817 (article 'Chromatics,' Supplement to "Encyclopædia Britannica") writes:

> "The elementary motions of the particles of the luminiferous medium are supposed to be principally confined to the line of direction of the undulation, while the most sensible effects of the waves depend immediately on their ascent and descent in a direction perpendicular to that of their progressive motion. . . . If we assume as a mathematical postulate in the undulatory theory that a transverse motion may be propagated in a straight line, we may devise from this assumption a tolerable illustration of the subdivision of polarised light by reflexion on an oblique plane."

But, writes Verdet, "The idea of transversal vibrations appeared a mechanical absurdity to all contemporary men of science," especially to Laplace and to Arago. The latter could never in his life decide to admit it as true, and Fresnel abandoned for a time an explanation based on this hypothesis.

In 1819, Arago and Fresnel published a Memoir on the mutual action between two rays of polarised light, and as a result of this, in 1821, Fresnel adopted the hypothesis of transversality in his Memoirs on mechanical considerations on the polarisation of light and on double refraction. One other experiment was required to disprove the emission theory, and this was first carried out by Foucault, who showed that light travelled more slowly in water than in air in accordance with the requirements of the undulatory theory. Newton's theory, as we have already seen, required the reverse result.

Another century has passed, and we have the quantum theory of radiation enunciated by Planck in his famous paper of 1901. Radiant energy leaves a radiant body, not continuously but in definite 'chunks'—quanta—depending on the frequency and on a constant, Planck's constant *h*, of which the value is $6{\cdot}55 \times 10^{-27}$ erg sec. The energy of the system is not equally distributed among the various modes of vibration, as required by classical mechanics; but little is found in short period waves; it is mostly concentrated in the low-frequency vibrations.

The law of radiation developed by Planck has been fully verified by numerous experiments; and the inverse problem, given that the final partition of energy is that determined by Planck's law, what laws of motion must be postulated for the system in order to obtain this law, was first solved by Poincaré (1912), who wrote: "L'hypothèse des quanta est la seule qui conduise à la loi de Planck."

Light is one form of radiant energy. Light then leaves a luminant body in quanta—light quanta—and this view has been developed by Einstein in his papers on light-quanta (1905) and the theory of radiation (1917). Such a theory has its difficulties; it contradicts at first sight much that we know from experiment about the interference of light. Thus Prof. H. A. Lorentz (quoted by Jeans in his "Report[1] on Radiation and the Quantum Theory") said at the Birmingham meeting of the British Association in 1913: "Now it must, I think, be taken for granted that the quanta can have no individual and permanent existence in the ether, but they cannot be regarded as accumulations of energy in certain minute spaces flying about with the speed of light. This would be in contradiction with many well-known phenomena of interference and diffraction. It is clear that if a beam of light consisted of separate quanta, which of course ought to be considered as mutually independent and unconnected, the bright and dark fringes to which it gives rise could never be sharper than those that would be produced by a single quantum."

While it is tempting to try to draw an analogy between Newton's corpuscles and light quanta, and possibly between his fits of easy reflexion and transmission and the probabilities of periodic changes in the states of motion of an atomic system from which the emission of quanta arise, there are difficulties in the way of the acceptance of any mechanical theory purporting to account for the emission of light, which, up to the present, have proved insuperable, unless, indeed, we may see in the new mechanics developed by Heisenberg and Schrödinger some means of bringing the various experimental results under some general law.

In a recent paper read before the Royal Society on the quantum theory of the emission and absorption of radiation, Dirac studies the interaction of an assembly of light quanta with an ordinary atom, and claims to show that it gives Einstein's laws for the emission and absorption of radiation.

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[1] For a discussion of the quantum theory, and of course of the problems here alluded to, reference should be made to this Report.

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Newtonian Time Essential to Astronomy.[*]

By Sir JOSEPH LARMOR, F.R.S.

"Let us now praise famous men."

THE HISTORICAL PROBLEM.

WHEN Newton undertook the unprecedented task of exploring the dynamics of the motions of the heavenly bodies, sparsely scattered in the vast depths of cosmical space, the preliminary and novel problem in front of him was naturally to settle their bearings. He formally established the principle that, though there may be one essential space, or æther, all spatial frames of reference are equally permitted in material dynamics provided their motion relative to this standard frame and so to one another is one of uniform translation. Thereby, for example, he was justified in referring the internal motions of the planetary system to the sun as if it were a fixed centre, although it is in motion with velocity then unknown: going even deeper, he showed how the apparent regular revolution of the directions of the stars could be proved, by experiment, to include them within the range of a frame of the dynamics constructed locally so as to be appropriate to the events on the earth as a whole.[1] But he curtly laid down the postulate that there is one universal reckoning of time. He even went on, in another context in more speculative vein, to assign to this physical absolute time a transcendental significance,[2] which has made it a battle-ground of philosophers from Leibniz onward. On these fundamental topics no degree of precision can be excessive.

The next essential progress in general ideas relevant to permitted frames of reference for dynamical science came from James Thomson, the engineer brother of Lord Kelvin, as late as 1884.[3] He recognised that the totality of such permitted frames form an interchangeable group: he invented for them the name 'frames of inertia,' which has been recently supplanting the term Galileian co-ordinates introduced in the relativity theory. He even propounded the fundamental question: given three systems of bodies in independent motion in the same space, under what conditions is it possible to discover a moving frame of reference in that space (and therefore a group of frames) relative to which their motions are all uniform translatory? The very idea of a frame of reference, as something requiring a name, seems to have originated with his direct and acute, but sometimes tedious, thought. He recognised the problem of simultaneity, but could not solve it: that had to wait for the modern group-theory. About the same time (1870) C. Neumann published discussions, that attracted far wider attention, in which motions are framed by being made relative to 'the body Alpha.'

In the higher theoretical astronomy rotating frames of reference have however been practically in use ever since Newton, but more formally since the brilliant initiative of Euler in referring the dynamics of a rotating solid body to itself.

The simplicity of the Newtonian frames of space and absolute time was disturbed practically, by the fact that our celestial knowledge comes by rays of light which suffer delay in transmission. Principles of correction, taking cognisance also of the motion of the observer, were introduced by the great practical astronomer Bradley, during Newton's life-time, which have remained adequate until this day.

But close tests on the propagation of the light itself, initiated by Michelson (1881) after an idea broached by Maxwell, indicated that things pass as if the velocity of light were practically the same absolute constant within all local environments, unaffected by the directions and magnitudes of their convections through space. This result, then unexpected and even paradoxical, became the stimulus to modern projects of complete local relativity, based on a general postulate (1900) that each local scheme of events is, so far as relates to the atoms of matter, self-contained. Its theoretical proof, up to the second order of approximation even within the atoms if only their structure is electric, rested on a principle of correspondence, which had in Lorentz's hands already (1892) given an easy explanation of the aberration of light and other first-order effects. Such theories, necessarily only approximate for application within the atoms, culminated in impressive practical form (1915) in the inclusion of gravitation by Einstein, leading to his astronomical predictions and their subsequent verification.

The confirmation (1919) of Einstein's prediction of the deviation of rays of light in the sun's gravitational field, at once placed these later developments of the dynamics of relativity in a privileged position, and made their critical study imperative. Later, the eclipse result has been enhanced by a gradual consensus of expert opinion regarding the alleged gravitational influence on the atomic periods of free vibration: but the original close explanation, by the theory, of the outstanding small residue of the advance of planetary perihelia has become less cogent on account of uncertainties of the astronomical problem.

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[*] Communicated to NATURE early in February 1927.

[1] Cf. the weighty scholium at the end of the *Definitiones* in the "Principia," where Newton lays down the necessity of a formal foundation of *Axiomata sive Leges motus.*

[2] Cf. the condensed theological metaphysic of the final *Scholium Generale*; also the Queries at the end of the "Opticks."

[3] *Proc. R. S. Edin.*: "Collected Papers," pp. 379-403.

COULD ORBITS BE ISOLATED GEODESIC CURVES ?

These predictions all rested on a postulate that in a planetary system of orbits, as represented symbolically in an Einstein-Minkowski fourfold continuum, each gravitational orbit is separately on its own account a quasi-geodesic curve, like a line of shortest length. But it has been held (1922) to be intrinsically impossible to reason on the basis that the warping of this auxiliary fourfold continuum is determined by the representative orbits within it, while at the same time each orbit is determined by the warping of the fourfold. The influences have to be treated as mutual: the necessary intrinsic invariance of Nature, holding amid all the accidents of arbitrary modes of reference, which at first pointed to the geodesic postulate as a suitable choice, must thus belong, as the invariant Hamiltonian Minimal Action does in the actual dynamical astronomy, to the system as a whole, not to the orbits separately. When, however, the orbital problem was examined[4] in the representative fourfold on this basis of a single mathematical Action function, originating in a field-Action, binding into a unity all the mutual influences, it appeared that the constant of gravitation had to enter into the expression for the Einsteinian absolute symbolic interval of fourfold space-time in the form γ instead of 2γ, leading to smaller potency of gravitation on light so that the two predicted optical effects of gravitation must each be halved.

The only criticism of this result of which I am aware was a remark to the effect that, if this is really so, then there must be something wrong with the application of the method of Minimal Action. Yet that method has continued to be, without substantial modification, the essential and eminently convenient foundation of the general fourfold mathematical theory of relativity. The astronomical verifications in agreement with the Einsteinian values, as they became generally accepted, have thus pointed insistently for several years to the necessity of finding some way of reconciliation of this alleged fundamental discrepancy in the theory. It was indeed clear enough that the rôle of astronomical time in the formulæ, as taken over from Einstein's own adaptation for his geodesic postulate, was unsatisfactory; but nothing better presented itself, though a slight error here involves great consequences. Various attempts at reconciliation, essayed by the writer during the last four years, have shown themselves inadmissible. It is easy, for example, to solve the problem, which is simply that of fitting gravitation within the domain of the optical and electrical relativity postulate, by means of a scalar potential of gravitation, introduced alongside the fourfold vector potential that is the expression of the electric and optical field: but that course, otherwise apparently unexceptionable, does not suggest any interaction between gravitation and light. Thus the actual astronomical detection of such an influence, as stimulated originally by Einstein's formulation, and carried through in the first instance in eclipse expeditions guided by Davidson and by Eddington with the help of the Astronomer Royal in the preparation, has now come to control the whole discussion in its own right.

DYNAMICAL TIME INHERENT IN THE INTRINSIC STRUCTURE OF MATTER, NOT IN FORMAL FRAMES.

The reconciliation of this discrepancy that will now be put forward is held to place the modern mathematical theory of relativity on its intelligible physical foundation. An actual astronomer is not an isolated solitary flying particle of the abstract mathematical theory. In his annual journeys at high speed round the extensive circumference of the earth's orbit, he takes his instruments and his landscape of reference along with him, without which he would be helpless: more important still, he takes his astronomical records extending over centuries of time, which have to be permanently intelligible and consistent to all brother astronomers, actual and potential, at all times and all places and moving in concert with their environments with all conceivable speeds. There must be something of the absolute involved here. The solution now offered is that our astronomer's own local space and time *are* absolute Newtonian space and time: that, unless we turn back from and reject the whole *corpus* of modern spectroscopic atomic doctrine, it is not possible to wriggle out of Newton's *dictum* of the necessity in dynamics of a universal continuous measure of time. Nor indeed do the creators of modern relativity attempt to do so, except in so far as many of them have become uncomfortable under the Einsteinian universal invariance of the time-space auxiliary fourfold interval, which as here interpreted involves and even imposes absolute time.

In the Einsteinian form of fourfold Action it is the modification of the time-like variable that dominates almost completely, as regards the actual universe with its slow motions, the forms of the symbolic tracks, because t enters into ds in the form cdt: when we have learned how to transform the symbolic track into an actual orbit in space and time with close accuracy as regards t, a much more rough adjustment will suffice spatially. Hence the importance of the utmost precision in the time-specification.

The extension of the environments of the astronomers, as enshrined in frames of the local standard, or so-called natural, space and time universal in character and the same for the environments of them all, into wider regions, is troubled by the fact that their only practical means of distant communication is by rays of light or other electric signals, which are delayed in transmission and affected by the motions of the observers. As regards astronomical observations that difficulty was discovered and surmounted as early as 1727 by Bradley, who, especially by his fundamental principle of aberration, founded and even perfected the science of practical astronomy. But not merely an approximate practical consistency; an absolute mathematical fit is required, though possibly of a kind which may never attain to verification, if the accumulated work of astronomers is to be intelligible in ideal completeness to intellectual scrutiny, notwithstanding every variety of position and motion of possible observers and recorders and the complexities of light-transmission, of all which complications an ideal foundation for the records of astronomical history must in theory take exact cognisance.

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[4] *Philosophical Magazine*, Jan. 1923, pp. 243-256.

It is held that the demand for universal intelligibility thus introduced, though of a generality which transcends any special *corpus* of physical science and so may appear at first sight to be unfruitful as being metaphysical, does point to a necessary and attainable actual construct within this domain of knowledge, that of astronomy and physics. Knowledge is rendered possible because, though the intrinsic times of all observers everywhere have to be identical because the local atoms are absolute in relation to their environments, yet the epochs or origins from which these times are measured in the various localities do not come into consideration at all, only intervals of time being concerned in the astronomical dynamics. It is this indetermination *à priori* of epochs, in conjunction with the absorption of all possible convections of local frames into simple invariance of the fourfold interval, that confers the requisite flexibility, permitting all the identical local reckonings of space and durations of time, of all observers everywhere in all ages, to be consolidated precisely within one wider auxiliary conglomerated fourfold scheme of mathematical representation.

The course of an astronomer's life, by the interpretation here advanced of the natural demand for relativity, works itself out of necessity under the sustaining local influences, is relative to his sub-permanent natural surroundings — this being indeed a type of postulate already recognised in mathematical form for similar reasons in the more minute cosmos of the atomic theory of elastic bodies. Our astronomer thus cannot know whether his environment is careering through space or not; that question must be meaningless to him, except so far as it is opened out by probable inference from the messages coming to his marvellously adapted sense of vision by light from the distant regions of the cosmos. In any case it is only his local smoothed-out frame of convenient reference, in which the occurrences that affect him are set, that can in any scheme of feasible simplicity thus be regarded as careering through space. He can and does construct his own Newtonian dynamical science of the motions observable within his local frame, often involving large relative velocities, even including local so-called centrifugal forces; and he could do this effectively though with far more trouble without calling upon light at all, just as if he and his associates were blind. Unless indeed the motion of the suitable local frame relative to adjacent permitted frames proves to be so erratic as to involve conspicuous differences of speed in its own adjacent parts, such as are called rotation: and then the remedy is to reduce the importance of the rotation, as can be done by increasing, by subdivision of frames, the fineness of the meshes of the analysis, so diminishing the extent of the local landscape which is the differential element, effectively uniform, with which a quasi-geometrical theory operates. Rotation of frames of reference, modifying velocities to an extent depending on the effective radius of the frame, appears on this view as a secondary and avoidable feature: in illustration, the rotation of the local element has added no term directly to the usual dynamical equations for a differential element of volume of a strained elastic solid.

The fact that the Lorentz transformation has to relate to convection without rotation is thus not now a harmful restriction. Moreover, on our view the influence of rotation can in any case be confined within the local frames, for it can be taken to belong to the dynamics of the bodies in the frame and not to the frame itself: a law of centrifugal force need not now belong to an unlimited frame and so extend away in increasing intensity, to be compensated at infinity. The original Newtonian argument from a spinning bucket, or in equivalent actuality the Foucault pendulum or gyro-compass, can demonstrate with the aid of light that the relative invariant property expressing fixity of gyrostatic directions within the frame, which the internal local Newtonian dynamics involves and can discover locally in self-contained manner, does actually extend outside as far as the fixed stars, which thus prove to be included within the region of spatial extension over which the play of physical theory is effectively Newtonian or uniform.

The directional fixations, unlike time, are thus local, not absolute; and the relevant question is, how far does the frame, for which they can be taken practically to subsist, extend: thus removing an insistent but, like unbounded centrifugal force, an unnecessary absolute. Or conversely, if we adopt as the expression of the natural notion of relativity, this idea that the convenient frames of reference of dynamics cannot be expected to extend uniformly to infinity or further than they can be tested, it points naturally towards trying a variable continuum, in which indirectly, as one may even say, Einstein discovered a suitable symbolic representation for an invariant gravitation. On the other hand, our immediate personal domain of local dynamics of matter can be so small that optical relativity merges practically in Newtonian relativity, the delays and other complications of light becoming negligible: but there is nothing to exclude another wider uniform frame, regarded as flitting across it, whose contents may be when so desired referred to it instead of their own frame, by aid of the Lorentz transformation which conserves the optical invariance all over it. This is the essential feature emphasised here, that the relations of pure relativity are concerned only with the specifications of localities in space and time, and prescribe the modes of adjustment and continuation of the group of the permissible local frames of reference: that the mutual dynamics of the masses existing in each local frame proceeds independently by Newtonian principles, if, as in Nature is actually the case, they arise in a landscape practically permanent as regards the larger features each within its own most convenient frame.

For example, on this formulation of the natural notion of relativity, an astronomer will be under no temptation to undertake a violent journey through the cosmos in order "to return on the previous night" as has been said and so rejuvenate the activities of his life, any more than he will be tempted to go to the antipodes in order to stand on his head.

Only relations are directly accessible to our knowledge, and in this domain most conspicuously of all. No progress has yet been made, any more than in Newton's day, in unravelling the essential nature of gravitation. No reason can be assigned why it is just as intense as we find it, or why it exists at all. What can be established by the Einsteinian verified predictions is that, being in some unknown way an essential feature of the physical universe, it does fall into line, as one had anticipated that it ought to do, with electrodynamics and optics in obeying the principle of local relativity, the regional self-containedness of local material phenomena, as above elaborated.

DYNAMICS IN A TWO-DIMENSIONAL COSMOS.

The analogy, and contrast, drawn from the Gaussian intrinsic geometry on a surface of variable curvature, by which these beautiful recent developments in a fourfold mathematical theory of universal relations in space and time were doubtless suggested, can be pushed a considerable way in this direction. We consider now not an individual explorer, but a whole population, whose activities are confined close to the surface on which they subsist, their thin cosmos of which alone they are conscious. Each community have their local world of events occurring in their local landscape on this sheet, and may construct, with a view to express the orderly succession of these events, their own local science of dynamics and physics. This science is conveniently laid down for each of the groups within a local frame of reference, which is flat or Euclidean, and can be envisaged as a uniform reference-lattice of straight lines; also in a local scale of time regarded abstractly as flowing uniformly, while determined practically by the prominent uniformities of recurrence in their phenomena. But when their region is extended too far, a misfit in their simple scheme rapidly develops; for the surface of their activities curves round, as we outsiders know but the inhabitants do not.

A theory of a wider cosmos cannot, however, arise at all unless the local populations possess some means of communication with one another. Let us consider a forest of threads stretched tight over their surface, and imagine that messages can be transmitted along them from each group to the others: these threads are so far the analogues of our suitable paths for transmission of rays of light. Without them, all these local frames of flat geometries and their related dynamics in natural time would subsist, but in isolation; without a very refined use of them there could be no kind of relation established between standard axes defining the expression of directions, in any two of the local regions, just as there is no overt relation between the epochs of the absolute times in our local regions also internally self-contained. But such inter-connexions can be worked up for them by constructing an auxiliary universal geodesic geometry (for example, spherical trigonometry) resting for its expression on the stretched threads, a conglomerate scheme which includes and also sums up all the local geometries. Though unbounded for them, it may even be restricted essentially, unknown to the inhabitants, to a finite, even possibly cyclic, domain as a complete frame for their cosmos, if the surface expressing our external, but to them abstract or symbolic and difficultly explorable, frame for the expression of their experiences closes up like an ellipsoid or solid ring: thereby relieving essentially the indetermination of the infinite. Their local plane geometries are here implied, that is, are postulated, to be all identical in type and scale—also their local experiences to be of the same type and therefore the time in which they are naturally set—that is, they are absolute in their dynamics.

This type of scheme involves, and is secured in its widest generality by, the analytic postulate, after Gauss and Riemann, that the squared interval of length on their surface, expressible as a quadratic function of the differentials of any two functions defining any lattice of coordinate curves determining position on the surface, is transferable all over it without change of value after the manner of a terrestrial surveying chain, is in fact mathematically invariant and absolute. Yet really all that our present science of differential geometry is usually capable of dealing with is gradual transfer, explored step by step on the basis of local differential equations. Here the rays of light are more potent than the threads or the geometry, for they can translate directly a finite interval of time, expressed in absolute atomic periods, across an almost unlimited range in the cosmos.

This is something beyond geometry, which imposes itself on the formal pseudo-geometric continuum determined by the postulated fourfold invariant interval. This latter, as already remarked, is able to create the fourfold scheme, because it can condense local frames, with all speeds of convection, within one element. How far this extraneous physical feature, the presence of light, tightens up the pseudo-geometric scheme we do not now stop to inquire; except to remark that it accentuates the absoluteness of time, as *sui generis*, already suggested and indeed provided for by the different sign of the relevant term in the expression for the quadratic interval itself. Nor will we consider the more recent problem set by Weyl and Eddington and followed up by Einstein, which really is how far a much wider type of frame for events, imposing only local relation between vector displacements of points, can be constructed so as to involve in itself, be consistent locally, and beyond by continuation, with the different and more tangible kind of foundation provided by postulation of invariant intervals such as distance—for it would seem, as has been already remarked, to be too loosely hung together to be identical with a geometric frame even combined with an arbitrary electric field, though such frames may well subsist inside it.

OTHER ELUCIDATIONS AND CONTRASTS.

There may be some instruction also in an analogy of our Newtonian Absolute Time T with the Kelvin Available Energy, A, in thermodynamics At each temperature of a material system under discussion, intervals of A are measured as definite amounts of absolute energy; which is in fact the essence of the perpetual-motion postulate of Carnot, there the analogue of the present one of a local absolute time. But in passing to a different temperature of the material system the origin or epoch of measurement of A has been lost, and it becomes necessary to include A as a feature in a wider auxiliary theory, introducing a new and universal formal quantity, the entropy of Clausius, in addition to energy and of different essence. But alternatively we can usually do without any such general scheme by relying, as is familiar in special problems, on special isolated cycles of change resting directly on the Carnot-Clausius principle, our general knowledge of Nature supplying the relevant foundation—just as here we might perhaps reason directly on the relations between the local Newtonian frames instead of merging them in the one fourfold consolidation which their law of mutual correspondence permits.

We may also perhaps illustrate in another different manner. The pseudo-spatial construct of Einstein-Minkowski has given us an inkling as to how the cosmos of discrete events in history may be laid out, as it would be present to the sensorium (to adopt Newton's term) of a divinity who would have knowledge of all occurrences, but necessarily in an incoherent manner , for coherence is foreign to direct awareness of the totality of things, being the compensation permitted to imperfect knowledge, to some degree artificially and arbitrarily, by relating the succession of events in some kind of co-ordinated fourfold index, or frame, of reference. This gradual development of coherence in the range of our experience in space and time, which is scientific method, must run into some calculus of representation, in this generalised problem provided by the multiple algebra of tensors. The mathematical theory, brilliant as it is, soon indicates that this consolidated point of view, apparently losing all distinction between past and future, would transcend human intellectual ability to develop, except in its very rudiments; at any rate until mankind have learned to deal with a formal pseudo-space in four dimensions with the same intuitive familiarity that they now cope with ordinary space in three dimensions.

On the other hand, the actual science of astronomy is an affair not merely of going on "observing coincidences of point-events" in the heavens, but of accumulation of coherent records extending over centuries, permanent human documents in which all the new observations must find absolutely consistent places. There can be no science without memory and without records. For it to be humanly feasible to find out, for example, from minute discussion in the long-continued records, whether there really is a very small residue, unexplained by Newtonian theory, in the precession of the apse of the planet Mercury, must demand, if even only as a practical measure, some definite way of reckoning duration that is independent of the accidents of place and time and motion of observers; just as the instinct of Newton briefly postulated. And when in the setting out of a timeless cosmic history in a fourfold transcendental scheme, our special human knowledge, in space and time, acquired in marvellous manner from the advance of optical science, that an atom say of hydrogen must be taken to be intrinsically the same whether it be in a seething star or on the earth, so is absolute, obtrudes itself into this hitherto merely abstract historical spread, and demands, what is indeed a very small fraction of what it involves, an absolute universal (Newtonian) time for itself in its own material environment, determined by its own permanent vibrational properties, science must eagerly grasp at this revelation as in fact bringing the Promethean fire down from heaven, and rendering, as the philosophers say, human knowledge possible in this domain.

If the present course of argument is valid, the essential proof hitherto that this inference from the absoluteness of the atoms is in fact the right one, is just the confirmation in actuality of the Einstein predictions as to the gravitational influence on light, especially on the period of vibration, which, as one has been forced to hold for the last four years, would otherwise rest on a foundation largely accidental. Without that direct astronomical verification, insistence nowadays on absolute local times might well seem an anachronism.

If we could contemplate history like gods, looking equally before and after, generalised matter and energy might conceivably present themselves, as the elaborated mathematical representation in the fourfold implies, each as a tensor having as many as ten essential components: and they might be perhaps within limits identical and interchangeable. But within the frame of structure of the absolute standard thought that is valid and exchangeable amongst the human race, there have been at length recognised these wonderful absolute atoms, existing as matter in their own rights without any sign of ageing or decay, being still in Maxwell's phrase "the foundation stones of the material universe"; and there has also been gradually acquired an idea of conserved energy which it has been useful to postulate as likewise universal and fundamental: and these two stand out as independent features of the foundations on which physical science builds; though related by the circumstance that the electric field belonging to an atom is proved mathematically to add to its inertia, otherwise naturally an absolute possession, by virtue of the energy of that field.

When two atoms approach and, by overlap of their fields, release in the form of radiation some of these intrinsic field-energies then partially superposed, a proportionate part of the inertia of the atoms goes away along with it, subtracted from their translational energies when the atoms become separated again unless indeed they have suffered permanent internal change in the process. This works out consistently: energy of electric activity, even of free radiation, carries inertia with it, and thus carries momentum too. But the assertion that the whole of the mass of an ultimate atom is energy would remain a barren though permissible[1] figure of speech, unless it means to assert a postulate that mass is somehow practically all separable electric and other field-mass arising from *motional* energy of merely formal nuclei with separable æthereal fields. This would compete with the idea of an electron as a field of *static* strain-energy essentially and irrevocably locked together around a centre. A development by Minimal Action, as indicated in what follows, can provide room for both kinds of mass, the intrinsic and the exchangeable, within the postulate of absoluteness of the atoms.

GRAVITATION REMAINS UNEXPLAINED.

The original case for the postulate that orbits are separately geodesic curves in the gravitational auxiliary fourfold was based, very forcefully, on the Newtonian identity of mass and weight, which otherwise remains a challenge, as an unexplained universal feature of matter. According to the marvellously precise results of Eötvös, working with his modification of the Michell-Cavendish torsion-balance, the force of gravity is found to be the same per unit inertial mass as exerted on all kinds of matter, this being actually verified beyond the order of 10^{-7} which is nearly as far as the order of the observed optical and electric relativities, namely 10^{-8}. If we reason on the basis of the Faraday type of concept, thinking however of a pre-ordained unchanging field of gravitational activity, then a collection of bodies composed of various kinds of matter move down the field in company, though with acceleration, not separating if they start with the same speed, almost as if they drifted in a current of fluid. If this field of gravitation is interpreted as merely a warp in a frame of space and time, this would naturally be regarded as a modification of the inertia which makes every free body describe, after the manner of Newton's First Law of Motion, on its own account alone, a representative path in a space-time auxiliary fourfold, determined by the purely quasi-geometrical property of minimal intrinsic quasi-length: and that is the gist of the geodesic postulate. But the other side of this consolidation of inertia with amenity to gravitation presents itself, when we reflect that a field of gravitation can vary, and so should have an assignable origin: which Newton found in an influence emanating from all the masses in the field, yet of a type of exceeding simplicity functioning just as if it were simple attraction according to his inverse-square law.

The Einstein mathematical theory can determine, at any rate as here amended, by self-consistent algebra in an abstract space-time fourfold extension, as a domain symbolically enshrining paths and masses of the bodies, a warp which proves to be necessarily restricted to a special type—just what is needed to represent gravitation. It has still to assume, however, after Newton and without explanation, that the mass which operates in this different function, that of creating the field, also is identical with the inertia mass. One may indeed reply that the geodesic postulate says nothing about mass: but it does determine a track along which the entity that determines the gravitational warp of the fourfold continuum is distributed, much as a magnetic field is determined by the tracks of electric currents,—a track which as above cannot be both direct cause and direct effect.

Though indeed the direct astronomical evidence to verify this identity of attracting mass with inertial mass may not as yet be very exact, the principle reposes firmly on a basis of its own, different from that of the Newton-Eötvös result; namely Newton's consideration that the accelerating influences between two masses rigidly connected together must be exactly balanced if motion is not to increase spontaneously without limit and so destroy any steady order of Nature. The argument from Eötvös carries only part of the way: this Newtonian doctrine of conservation of momentum is essential as well. But the latter is mutual dynamics of bodies, rather than geodesic geometry of an isolated track in a warped pseudo-space. It involves mutual relation between all the bodies in the field, bodies which also create the field: and this concurs with the previous conclusion that the path of each single body can hardly be regarded, except by an argument moving round in a circle, as a minimal inertial track in a continuum which that track itself has a share in modifying or even creating.

A study, in the light of this point of view, of the crisp exposition of principles in the first four sections of Einstein's earliest formal exposition of 1916 shows how easily it could have been turned round into the present direction. His 'natural' or absolute time, here adapted into the forefront of physical theory, is there practically put away in favour of a fourfold variable, transcending space and time,[2] and necessary to the auxiliary algebraic tensor theory, which is no more time than entropy is energy. It was natural in advance to presume that the symbolic path of a body, at any rate of an infinitesimal particle, was expressible as a minimal inertial track as if in a pre-determined continuum, until it appears as here maintained that this could not conform to actual gravitation as one mutual force between two bodies.

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[1] But only up to the second order.

[2] It seems to have imposed itself originally in a very interesting exploring discussion, 'on the influence of gravitation on light,' *Ann. der Physik* (1911), § 1, English translation, p. 106, prior to the opening out of the general problem.

The discipline known as the mathematical theory of relativity would on the present view become a condensed census of the mutual necessary relations of the group of permitted frames of reference, in which investigators variously situated in space, time, and motion may conveniently and consistently formulate the physics of the local worlds, of infinite variety, to which they belong: but the cosmos is far more than its frame or even than our most far-reaching yet still superficial analysis of it within that frame.

It is a modified Newtonian physical foundation that has here been summarily set out. After all, if the present view justifies itself, it will be no derogation to the brilliant scheme of mathematical co-ordination of the general relations of gravitational and electric fields worked out by Einstein, and indeed not pressed by him (originally at any rate) to any transcendental issues. And on any view we have to admit that gravitation, like the great bulk of the rational exact principles of uniformity discovered by science in Nature, physical and biological, still in essence continues to lie beyond our scrutiny.

RELATION OF ABSOLUTE TIME TO THE AUXILIARY FOURFOLD HYPERCOSMOS.

It is becoming widely recognised—it seems now to be Einstein's own considered opinion—that an absolute transferable interval of space-time, the analogue of a universal measuring chain, cannot be avoided, however eager be the quest for an unconditional relativity of physical knowledge. It is here maintained that the difference in sign gives the time-element a footing independent from space in that symbolic absolute interval: in a sort of analogy to this, the general fourfold invariant tensor has been recognised recently as involving fundamentally, for the abstract relativity theory, two independent tensor *data*, a symmetric one and a skew one. When absolute time is thus taken out, the remaining part of the interval, giving the foundation for spatial determinations, is to be associated with an absolute lattice-frame locally uniform or Euclidean.

The pseudo-spatial auxiliary fourfold continuum of Einstein is made up by fitting together, so to say by dovetailing, the sub-groups consisting of all the local convected frames of reference (frames of inertia) which are suitable to enshrine the local Newtonian dynamics of ordinary experience belonging to the various environments in the cosmos. These variously convected local frames of reference, adapted for each domain of experience, but all condensed into one element in the auxiliary fourfold, which is effectively differential in the sense of differential geometry, may be presumed, in the search for a *locus* for gravitation, not to fit together into one universal group symbolically extending over the whole fourfold pseudo-space, without some straining of each of them, such as would cumulate sensible effects at places further removed from the centres of their localities. An essential feature is that this warping is here put on the frame, in preference to an equivalent warping of the laws of the local Newtonian dynamics that the frame enshrines. It is now well recognised that it might be put on either: the frame might be taken to be absolutely uniform throughout the universe, at the cost of complicating the expression of the experience formulated within it.

The essence of relativity as a practical proposition is that the scheme of knowledge is relative to some suitable frame of reference: it may be a matter of facility of exposition how much of universal relations is put into the frame, and how much is treated as belonging to the local dynamics of the system of bodies whose phenomena are referred to that frame. This is the key to the present treatment: everywhere there is the convenient frame of reference: it is relative to that basic frame, not to one another, that the local events are most simply and concisely expressed: such local frames, convenient and practically indispensable, have to be grouped together, consolidated into one compound scheme in order that scientific knowledge gained in the locality, in space and time, of one of them should be transferable into the localities of the others. That becomes possible, because all local frames, however differently convected, can be consolidated within one element of the fourfold by the Lorentz transformation, so that, the convections being thus disposed of, only space-time distributions remain to be fitted together, by strain if that proves to be necessary for the convenient expression of Nature.

The choice, however, of the local frames has here developed into more than a matter of convenience. The thorough absoluteness of the symbolic Einsteinian interval, involving, as here asserted, absolute time as well as a universal measuring chain for all local spaces, now working in concert with the marvellous practical instrument we have come to possess for exploring material systems far outside our own dynamical environment, allows us not indeed to envisage directly the universal symbolic composite frame which subsumes all the actual local ones, but to carry through experimental tests for the formal validity of any attractive mathematical representation thereof that we may be able to contrive. The rays of light enable us actually to transfer directly the intervals of t, one of the fourfold auxiliary set of co-ordinates in this composite universal frame, being that one which is more specially related to time, from one part of the universe to another.

The differentials (δt) of this co-ordinate that are associated with the ray-pulsations stand locally in connexion with intervals of absolute time (δT) which are intrinsic for all environments, by a relation that may involve local gravitation among other things: it is the spectrometer that can provide the test whether this constructive process for communication with distant systems is in actuality verified,—and that in a way that Newton could hardly even have imagined. First the absolute period of vibration (ΔT) of the solar hydrogen atom is to be transferred into an equivalent interval $\kappa\Delta t$ ($=\Delta T$) in the universal auxiliary co-ordinate t of the minimised fourfold; then the very same absolute period, namely ΔT, of a terrestrial hydrogen atom may be observed and also can be transferred into the equivalent interval $\kappa'\Delta t'$ expressed in this co-ordinate t by the ratio κ' appropriate to terrestrial instead of solar environment; thus giving $\kappa\Delta t = \kappa'\Delta t'$. As it is the auxiliary period Δt that is transmitted by undulation along the ray and received into the spectrometer, that instrument functions *as if* it were measuring directly two different actual periods $\Delta T/\kappa$ and $\Delta T/\kappa'$. For vibrating atoms at rest in the solar frame $\kappa = (1 - 2V_s/c^2)^{\frac{1}{2}}$ where V_s is the gravitational potential of the sun: for a terrestrial atom κ' is practically unity. This agrees with the Einstein prolongation, now only *apparent* not intrinsic, of the periods of the solar radiation. If the atom were moving with speed v in the solar frame of reference, instead of being at rest, the Lorentz transformation as *infra* would seem to impose another factor $\epsilon^{-\frac{1}{2}}$ or $1 - \frac{1}{2}v^2/c^2$, on the period, which is in the opposite direction but wholly swamped by the Doppler effect.

This feature, that every interval Δt is conveyed without change all along the representative ray-path of the auxiliary fourfold, is based on the nature of the undulation along a ray; it rests in theory on the circumstance that the electrodynamic optical equations, as transferred into the invariant form inherent in this composite fourfold $(xyzt)$, are satisfied in undulatory manner, not exactly but to adequate approximation, by making the variable t enter in the expression of the solutions only through a universal periodic factor e^{ipt}. It is the absoluteness of the hydrogen or other atom, steadily maintained through all vicissitudes of place and motion even doubtless of acceleration of its environment, referred to its own frame that accompanies it, for which internally the translatory motion means nothing, that provides a universal natural measure of an absolute flux of time T, namely that of any one of its intrinsic types of vibration: it is the spectrometer alone that in quite recent times has become available to extend our local dynamical experience practically and directly into a universal scheme of intervals of time everywhere absolute, such as is involved symbolically in the universality of the Einstein space-time measuring interval.

In terms of universal Newtonian time thus acquired, the permanent results of astronomy have to be expressed; for its accumulated records must be in accord with the local measuring appliances, pendulums, gyrostats, marks of local direction, position, etc., on which observers wherever they be in space and time and however convected have to rely. This postulate of local frames of reference in space and time, enshrining their material dynamical contents, everywhere Newtonian and absolutely identical just because dead matter and its manifestations are presumed to be identical in type everywhere, is already latent in the preconception of a *continuous* differential geometry applicable to the fourfold: that the frames can be thus consolidated therein, conveniently and manageably to sufficient approximation, along mathematical methods such as the one that Einstein has opened out, is from the present point of view consistent with our fundamental requirement that as knowledge proves to be possible and enduring, the modes of its acquisition and record by all potential observers of natural phenomena, however variously situated in the cosmos, must be consistent among themselves.

THEORETICAL COHERENCE IS ENSURED UNDER LEAST ACTION.

It remains to indicate briefly how these ideas modify essentially the mathematical analysis and its interpretation, without unduly disturbing Einstein's famous three tests, postponing for the present other issues that incidentally arise.

We base the whole development, after Einstein, Hilbert, and Lorentz, and recently Whittaker who has attempted a striking electrodynamic generalisation, with ideal security and simplicity, on one invariant scalar integral, extended over the fourfold conglomerated representative continuum in which the symbolic history, past and future, of the cosmos is spread out, namely,

$$A = \int (G + L + \lambda) d\tau.$$

That integral is the closest available analogue, in this mixed $(xyzt)$ continuum, of the Action integral of Lagrange and Green framed in ordinary space with independent time, as applied to develop the laws of undulatory disturbance whether in a continuous elastic material body or in an æthereal optical medium. Here L is the analogue of the Action-density of the elastic or electric field; λ is a constant which may be needed to satisfy the restrictions of our point of view, the analogue of a pressure which was familiar in early optical theory as necessary to adjust across an interface undulations purely transverse like those of light, occurring in a medium supposed to be incompressible; G is a multiple of the Riemann scalar curvature-invariant which confers just the suitable intrinsic freedom when the basic fourfold is now contemplated after Einstein as non-uniform, while its element of extension $d\tau$ then involves the familiar scalar factor $\sqrt{g}$.

This formulation of a compound Action-density, which is to become expressive of universal dynamical history, is first to be minimised as regards its distribution, with reference to variation of structure of the fourfold pseudo-space, as in the end controlled by its material contents expressed symbolically by their historic tracks therein. This variation leads to structural differential equations of that fourfold, thus conferring on it a definite character of the Riemannian geometric type. Within the pseudo-spatial connecting structure thus established, the Action can now be integrated by parts, leading to boundary terms along with a different spatial integral: it may be that the spatial integral vanishes, and this will occur under quadratic conditions. The boundary for such integration in the fourfold consists, in an atomic theory, of the surfaces of very thin filaments enclosing the historic tracks of the atoms and electrons which alone are out of bounds: the boundary integral is reducible practically to line-integrations along those tracks. The Action A may thus, on account of the structure of the field as already settled by its own variation, be expressible as made up of parts associated with the material system alone as represented by the historic tracks of the atoms or finite masses. It is now to be further minimised[7] with respect to variation of these historic tracks, that is, of the representation of the history of matter: that will lead to the expression, suitable to the fourfold, of the dynamical equations of interaction of the atoms, in fact to a *symbolic* dynamics of the matter that is present in the field, now latent, which itself arises from that matter as nuclei or mathematical singularities of suitable type, in accordance with the laws determined by the previous variation in the field itself: all this mutual complexity, being held firmly in check by its origin from a single Action formula.

The Guidance of Classical Electric Theory.

This process is directly suggested, and has even been guided, by cognate Maxwellian electric theory:[8] the special case of a system of linear electric currents in space affords a close analogue of the historic linear tracks of atoms. In that theory the energy of the currents—there a kinetic part T and a potential part W—is postulated to reside, possibly as strain and motion, in the dynamical field of the interconnecting medium or æther. An Action-density L in this medium, or kinetic potential $-L$, is formulated analytically, being equal to $T - W$. The Action $\int L d\tau' dt$, $d\tau'$ being spatial, thus expressed by local elements, is minimised over all the field, thereby adjusting the electrodynamic field to a coherent structure, presented in the form of its Maxwellian absolute circuital equations. With this field-structure, so determined, the energy, and the Action, become condensible into expressions in terms of the currents alone that are the sources of the field, in the form of line-integrals involving their circuits: the result as regards the kinetic part is represented by F. Neumann's energy formula, on Amperean lines, for linear currents in terms of the ancient current elements such as ιds, namely a mutual energy

$$T = \Sigma \iint \frac{1}{r_{rs}} \iota_r ds_r \iota_s ds_s \cos(ds_r ds_s).$$

Incidentally and more precisely, when the current is expressed in ultimate form as made up of electrons, the complete Action, as it has now to be, in form suitable to the fourfold, is

$$A = \Sigma \iint \frac{1}{r_{rs}} (e_r dx_r e_s dx_s + e_r dy_r e_s dy_s + e_r dz_r e_s dz_s - c^2 e_r e_s dt_r dt_s);$$

for this form is invariant (except in one feature as regards r_{rs} which leads to a different story that would now carry us too far) and involves the two sets of independent variables $(x_r y_r z_r t_r)$ and $(x_s y_s z_s t_s)$ in the fourfold, expressing position of each pair of interacting electrons but not any one universal time t. Reverting to Maxwellian theory, the forces between the bodies carrying the electric currents are then determined by further variation applied to the Neumann formula, now with respect to change of form of their circuits, in time, by variation with respect to position without further reference to the field, still in the background but already previously settled: and that in fact constitutes the Neumann energy-theory. If we wish to avoid specifications in terms of any concept of mutual forces, this process of minimising a scalar Action by variation can lead direct to the complete set of equations of motion of the conductors that carry the currents.

One essential point the analogy brings out prominently. It will not do, after Hilbert and most writers on this subject, merely to add some suitable invariant form of line-integral to the field Action A in order to express the interactions of the material atoms. The Faraday-Maxwell doctrine is that the energy, or in complete general dynamics the invariant Action, all resides in the field, there being no other; coherently, in that the field adjusts itself minimally to laws that permit this energy, other than free energy expressed as radiation, to be associated permanently with its sources, the atoms or electrons constituting the currents, and thus to be treated as belonging to them.

We have to determine what form the corresponding generalised Action, thus reduced to material form, ought to take in the fourfold problem. The Neumann formula suggests a double integral extended along each pair of the circuits or historic tracks. Under certain limitations (now postponed) it is reducible to a single integral, analogous to the Maxwellian kinetic form involving the electric potential $(FGHV)$, namely

$$\Sigma \int e_r (F_r dx_r + G_r dy_r + H_r dz_r - c^2 V_r dt),$$

involving with Maxwell dt not dt_r. There arises also naturally here, in regard to the fourfold, a local part deriving from mutual activities of the nature of self-induction between the sub-filaments of the cylinder-track of the moving electron, which adds a term $\mu_r ds_r$, where μ_r is a constant expressive of the familiar electric inertia; this part is directly suggestive of the modified Einsteinian intrinsic inertial form now to be introduced, to which an electric part like the above is to be added as the reduced expression of electrodynamics.

Previous Analysis by Action revealed Discrepancy with Fact.

In the previous effort towards this type of gravitational theory, already referred to (*Phil. Mag.*, Jan. 1923), a linear form of integral was assumed for this reduced Action, as being the nearest analogue of the Einstein geodesic form which connects itself so readily with dynamical orbits. This restricted the choice to the only available type of invariant linear form, which is

$$A = \Sigma \int -cm_r ds_r;$$

where locally in each frame ds^2 reduces by suitable change of co-ordinates to the absolute intrinsic standard form $c^2 dT^2 - d\sigma^2$ where $d\sigma^2$ is Euclidean, while all over the fourfold it is expressed continuously in terms of universal co-ordinates by an invariant quadratic differential.

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[7] This is not the procedure for determining *actual* orbits in space and time. This reduced Action has the requisite invariance, from its mode of formation: and it can now be transferred from the timeless fourfold into a frame in space and time as *infra*, when it becomes the ordinary dynamical Action of the planetary system as referred in space and time to that frame.

[8] Cf. "Æther and Matter" (1900), Ch. vi, especially §§ 56-9.

We now introduce the Schwarzschild expression for the spatial-gravitational field as modified by the symbolic track of a mass m moving with changes of its speed restricted to be very slow compared with the velocity of light, namely

$$ds^2 = c^2\left(1 - \frac{km}{c^2r}\right)dt^2 - \left(1 - \frac{km}{c^2r}\right)^{-1}dr^2 - r^2d\theta^2 - r^2\sin^2\theta d\phi^2.$$

Or better for the problem of several interacting planets, the earlier but less exact Einstein expression

$$ds^2 = c^2\left(1 - \frac{km}{c^2r}\right)dt^2 - \left(1 + \frac{km}{c^2r}\right)(dx^2 + dy^2 + dz^2),$$

which is spatially isotropic and so adapted to superposition of disturbing influences. Our direct immediate concern is the question whether, in order to express gravitation within the scheme if that proves to be possible, k must be identified with its absolute constant γ, or with 2γ, the first alternative halving the gravitational effects on light as originally predicted. With sufficient accuracy for this purpose we have for the field of a system of planets the collective isotropic form

$$ds_r = cdt_r\left\{1 - \Sigma\frac{km_s}{c^2r_{rs}} - \left(1 + \Sigma\frac{km_s}{c^2r_{rs}}\right)\frac{v_r^2}{c^2}\right\}^{\frac{1}{2}},$$

$$v^2 = \frac{dx^2}{dt^2} + \frac{dy^2}{dt^2} + \frac{dz^2}{dt^2},$$

from which by further approximation in which the square root is expanded, keeping only the most important terms, we obtain for the Action the expression

$$A = \int\Sigma dt_r\left(\tfrac{1}{2}m_rv^2_r + m_r\Sigma\tfrac{1}{2}\frac{km_s}{r_{rs}} + \ . \ . \ .\right) + \text{constant}.$$

Now compare this with the ordinary dynamical Action from which by itself alone the entire system of equations of motion of any planetary astronomical system is derivable, namely,

$$A' = \int(T - W)dt = \int\Sigma dt(\tfrac{1}{2}m_rv^2_r + \tfrac{1}{2}m_rV_r), \quad V_r = \Sigma\frac{\gamma m_s}{r_{rs}},$$

where V_r is the gravitational potential of the other masses at m_r. The former expression involves a plurality of independent co-ordinates t_r as free variables, one belonging to each body on its historic track: the latter has the one time-variable t. The former variables must somehow be reduced to a single one, in order to be expressive of the progress of history from stage to stage.[9] In default of anything better, we previously, following the usual tacitly adopted course, simply substituted the same dt for each of these independent differentials dt_r; as the result we had

$$A = \int\Sigma dt\left(\tfrac{1}{2}m_rv^2_r + \tfrac{1}{2}\frac{k}{\gamma}m_rV_r\right).$$

On that pure assumption it proves to be possible to establish the necessary agreement between A and A', merely by equating k to γ: whereas the geodesic postulate that each orbit is determined by itself alone from its own equation $\delta\int ds_r = 0$, with the same identification of dt_r with dt, would obviously, with Einstein, make k equal to 2γ.

Thus by use of the single invariant mutual Action, instead of the plurality of geodesic forms which as we hold are only spuriously invariant, both optical effects of gravitation were, on adopting perforce the usual procedure, reduced to half their observed values.

The weak link in the argument was recognised at the time, and has been already here sharply indicated. As nothing better suggested itself, the usual course was followed by replacing the independent co-ordinates t_r, t_s, . . . expressive in part of the positions of the bodies on their tracks in the fourfold, by one universal time-variable t. In another aspect, instead of conducting a general variation of position in the fourfold, it was restricted to displacements confined to hypersurfaces transverse to t; which is not an invariant or intrinsic process, because t may belong to any slicing whatever of the fourfold.

NEWTONIAN TIME NOW INTRODUCED.

We now claim to be in a position to do better, as the Newtonian absolute time T has been acquired. The t_r is the variable of the type of time that is appropriate to the material system m_r referred to the convenient frame of our problem in which all the local systems are taken as moving, this one with velocity v_r. It can be placed in relation to T, which is the time-variable appropriate to its own frame, changing relative to the others, in which m_r is always at rest, by a Lorentz transformation expressed at each stage, if x_r is taken for brevity along v_r, by equations of type ("Æther and Matter" (1900), p. 174: Lorentz, *Proc. Amsterdam Acad.* (1904): Einstein, *Ann. der Physik* (1905))

$$\delta X = \epsilon^{\frac{1}{2}}(\delta x - v\delta t), \quad \epsilon = \left(1 - \frac{v^2}{c^2}\right)^{-1},$$

$$\delta T = \epsilon^{\frac{1}{2}}\left(\delta t - \frac{v}{c^2}\delta x\right).$$

Here, now introducing subscripts, δX_r, δT belong to the particular planet's own frame, δx_r, δt_r belong for each planet to the solar frame to which the motions of all the planets have to be referred in a theory which includes them all. It is the transfer from δt_r to the universal δT, which is none other than the (reversed) familiar very slight relativity shrinkage of time, of order 10^{-8}, that rises to be an essential feature for orbits because δt always occurs with a factor c. The transfer is effected by the relation $\delta t_r = \epsilon_r^{-\frac{1}{2}}\delta T$; provided we can ignore the addition $-v_r/c^2 . \delta x_r$ to δt_r in the formula, which expresses a change of epoch of T with locality analogous in Lorentz's striking comparison to change in civil terrestrial time for different longitudes. If our local standard frame of inertia, that is, such that dynamics of its material content is practically uniform and Newtonian, is not of too great extent, this omission makes no practical difference: the theory has however to remain approximate, though abundantly covering actuality, in this as in other respects, leaving the practical issues for systems involving speeds of a higher order than planetary still a riddle.

We can now introduce into the Action this unique absolute time T as subsisting intrinsically within every moving system m_r. But it may still be objected that t, as usually introduced in place of

[9] It is just the negation of this consideration that has led to deposing time into an accident of place and motion, and so to abolishing history.

t_p, t_q . . . could be regarded as the absolute time on the sun, to which the motions of all the planets are thereby referred. This remark may suggest a contradiction in our processes: but it is removed by reflecting that though T is measured in the same unit on the sun and on a planet, being absolute, yet it is measured from different epochs, which we cannot specify, and which do not keep constant for the succession of elements of T because the planet's own frame of T is continually changing relative to that of the sun. The only δT that is a continuous differential of a function T, for the environment of the planet in which the process of variation is carried through, is by Newtonian postulation that one which constantly belongs to it, with its optically vibrating atoms, when referred to a frame continuously carried along as part of itself. It is this T that is the unambiguous cumulating time of the records of the astronomers, who work each in his own essential local landscape in which, as in all others, it inheres.

Reverting after these explanations to our analysis, by a simple substitution for dt^2 within the radical, we now have immediately, using isotropic forms for ds^2, with sufficient approximation[10]

$$A=\Sigma\int -c^2m_p\left\{\left(1-\Sigma\frac{km_q}{c^2r_{pq}}\right)\left(1-\frac{v_p^2}{c^2}\right)dT^2-\left(1+\Sigma\frac{km_q}{c^2r_{pq}}\right)\frac{d\sigma_p^2}{c^2}\right\}^{\frac{1}{2}},$$

$$=\Sigma\int -c^2m_p dT\left(1-\Sigma\frac{km_q}{c^2r_{pq}}-\frac{2}{c^2}v_p^2+\ .\ .\ .\right)^{\frac{1}{2}},$$

as $dt_p=\left(1-\frac{v_p^2}{c^2}\right)^{\frac{1}{2}}dT$, $d\sigma_p^2=dx_p^2+dy_p^2+dz_p^2=v_p^2dT^2$, the product terms of higher order under the radical in A now, be it noted, cancelling out. Comparison with the Newtonian Action now restores k to the value 2γ as with Einstein; but the result may still differ (see, however, footnote *infra*) by second order terms from the Newtonian Action in a way which might affect sensibly the secular advances of the perihelia of the planets.

We claim in fact to have discovered how to transfer, with sufficient approximation, the reduced form of Action, constructed in the conglomerated fourfold in order to secure the requisite invariance, into the solar frame in space and time of the planets, which is competent to contain it and will lead to the development of dynamical astronomy by further variation in the usual manner with respect to the planetary positions.

Introduction of the factor transforming from the co-ordinate dt_p to a universal time dT has thus affected the kinetic energy of each body as it occurs in the reduced integrand of the Action with a factor 2, together with minor changes: and to restore large-scale agreement with the astronomical Action A' the potential energy has to be affected with the same factor, which requires us to make k equal to 2γ instead of γ. This new inconvenient common factor 2 would then be absorbed by amending the original Action form to $A=\Sigma\int-\frac{1}{2}cm_p ds_p$, a change that will presently prove to be essential as regards the relation of mass to energy.

But a point arises here that demands close scrutiny, as it may be a main source of obscurity. Reduced to standard local form the transferable invariant ds is expressed by $ds^2=c^2dt^2-d\sigma^2$; as ds is thus cdt for a frame in which the $d\sigma^2$ of a track locally vanishes, it has been customary in the theory to call $c^{-1}ds$ standard time. If this is meant to be the same dT as the present interval of absolute time, it involves the relation

$$dT=c^{-1}ds=\left(1-\frac{v^2}{c^2}\right)^{\frac{1}{2}}dt=\epsilon^{-\frac{1}{2}}dt,$$

whereas our present result, derived from an immediate comparison of frames, is the direct opposite one, $dt=\epsilon^{-\frac{1}{2}}dT$. The justification for it is, briefly, that the Minkowskian fourfold determined by invariance of ds is not a frame of reference for matter in motion; its element of extension is rather a complex of local frames with all speeds of convection. Neither matter nor motion is discernible within the fourfold: it is on the present view a necessary consolidation of the relations of the permitted (locally inertial) frames, in any one of which the actual world can be framed as bodies in motion. But it bears traces of this composite origin, from groups of local frames with all possible motions of convection, in the historic tracks which are indirectly symbolic of the movement of bodies as exhibited in any of the merged constituent frames.

The $c^{-1}ds$, though it has been called standard time, has nothing to do with any moving material system: it is to the local material system itself in its own frame, as the essential *datum*, not to any or all of the other extraneous permitted frames of reference in their various convections relative to it, that the absolute time belongs. Though perhaps a relation between the epochs of T in two local systems is determinable ideally by counting the alternations in t along the undulatory ray connecting them, yet as time progresses the ray rapidly changes owing to their motions and no practicable relation could ensue. Or, expressed differently, the frame of the planet is constantly changing relative to the solar frame, which prevents a steady difference of time-epochs between their frames.

When we come, however, to determine the deflection of a ray passing near the sun it is the spatial gravitational field adjacent to the sun with which we are concerned. Referring the rays to the frame of the sun, the electrodynamic theory shows that the coefficient of dt^2 in the expression for ds^2 expresses with adequate approximation the square of velocity of light near the sun, while the curvature of the ray is by Huygens' principle the local gradient of velocity along its normal.[11] Thus the Einstein deduction for the deviation of the ray holds good with his coefficient 2γ as now restored, but on a different foundation, in place of γ.

RELATION OF ELECTRIC MASS TO ENERGY DEMANDS NEWTONIAN TIME.

The point has not yet been considered that the time-like co-ordinate t in the fourfold is not unique; for it is one of the impressive features in general relativity-theory that any mode of slicing of the hypercosmic fourfold may equally well express it. But what we are concerned with in our actual approximations is the simplified case which Levi-Civita has called Einsteinian statics, in which ds^2 involves no products of dt with other differentials: the ambitions of the wider abstract theory are scarcely practicable, and may be excessive. The motions of all local systems which have speeds small compared with light are then represented by historic tracks, now in a real (x, y, z, ct) fourfold, which are almost parallel: and the co-ordinates $t_r, t_s \dots$ of the various systems are suitably measured along some direction for t nearly parallel to them all. It is this simplification which makes an approximate development of the fourfold scheme practicable for actual astronomy, while leaving its relations to actuality unsolved for higher speeds.

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[10] If a track p is regarded as made up of filaments which influence one another the summation $\Sigma km_q/c^2r_{pq}$ ought to be increased by a constant k_p which is a sort of gravitational self-induction like that of an electric current on itself. This would function as a field-addition to mass, did it not cancel out as occurring in two places with opposite signs: there is no field-inertia of gravitation.

[11] This needs closer elucidation, now postponed.

It will be noted that in circumstances where the gravitational potential is negligible, the direct inertial part of the Action, as now expressed by

$$A = \dots + \Sigma\int -\tfrac{1}{2}cm_r ds_r,$$

where $$ds_r = cdt_r\left(1-\frac{v_r^2}{c^2}\right)^{\frac{1}{2}}, \quad dt_r = \left(1-\frac{v_r^2}{c^2}\right)^{\frac{1}{2}}dT,$$

becomes $$A = \dots + \Sigma\int -\tfrac{1}{2}c^2m_r\left(1-\frac{v_r^2}{c^2}\right)^{\frac{1}{2}}dt_r$$

$$= \dots + \int\{\text{const.} + \Sigma\tfrac{1}{2}m_rv_r^2\}dT,$$

when each system is referred to its own intrinsic absolute time; thus indicating that essential mass of an atom, as distinct from inertia derived from an attached field to some degree separable, is an intrinsic constant m_r, unaffected by its relation to frames of reference, as naturally it ought to be.[12] It would only be electric field-mass that is affected by its velocity in the frame, being related to field-energy relative to the frame.

Moreover the latter relation, fundamental though it be, is *not* substantiated at all except on the present Newtonian scheme. For an electric system it is common ground that the relevant reduced Action, of fourfold invariant type, must be of form, again with the new adjusting factor $\tfrac{1}{2}$,

$$\tfrac{1}{2}\Sigma e_r\int(F_rdx_r + G_rdy_r + H_rdz_r - c^2V_rdt_r),$$

where $$F_r = \Sigma e_s\dot{x}_s/r_{rs}, \quad V_r = \Sigma e_s/r_{rs}.$$

For a static electric system it is thus, closely,

$$-\tfrac{1}{2}\int\Sigma c^2e_rV_rdt_r, \text{ becoming } -\int Wdt,$$

where W is its electrostatic energy, when all its electrons are travelling together so that t_r is the same for all. On introducing Newtonian time, but not otherwise, this is

$$-\int W\left(1-\frac{v^2}{c^2}\right)^{\frac{1}{2}}dT,$$

which is the familiar form of Action indicative of varying inertia according to a law which makes the energy $W(1-v^2/c^2)^{-\frac{1}{2}}$, thus showing its dependence on the translatory motion. For example, to our second order of approximation this Action is

$$\int\left(-W + \tfrac{1}{2}\frac{W}{c^2}v^2 + \dots\right)dT,$$

indicating an increase of inertia of amount W/c^2.

CONCLUSION.

The conservation of Newtonian absolute time for local material systems, as supplied by their intrinsic vibrating atoms of matter, within the Einstein mathematical method of fitting the existence of gravitation into the optical relativity, has thus led to his value of the displacement of spectral lines, also as we have seen to his value for the ray-deflection, but not to his result for the precessions of planetary perihelia.[13]

It is noticeable how little use of the mathematical tensor theory is required for the general argument on the scope of relativity: it here provides only the form of ds^2 for the gravitational field within the solar system, as affected by each mass that is present, and that form is required only to a rough approximation, in order to identify a representation of gravitation within the formulation by ds^2 of the invariant fourfold, though closer calculation is necessary in order to determine the deflection of actual rays and the precessions of planetary perihelia.

Finally it will be observed that the present scheme has to be throughout an approximate one, leading as is claimed in a natural manner to the two optical effects of gravitation as now widely accepted. It works with frames of ordinary space and time, correlated in an auxiliary mathematical fourfold. It may be regarded as the continuation of the previous approximate scheme of electric equivalence of frames, of long ago, "Æther and Matter" (1900), Chapters vi, xi, which at that date covered adequately all the verified facts of optical and electrodynamic relativity, and justified the postulate of its universal validity at any rate up to the second order: without noticing, however, as Lorentz afterwards discovered by an equivalent independent electrodynamic formulation, that the formulæ on which it was based are obviously valid without approximation for the Maxwellian field; though valid only problematically, if at all, within the domains of the atoms, except to the second order of approximation there regarded as imposed on that account. The hypothesis of unrestricted exactness, regardless of structure in the atoms, has eventuated in wide and profound formulations towards hypercosmic schemes, which constitute the modern mathematical theory of relativity. The physical interpretations here advanced rest of course on the most brilliant Einsteinian fourfold device for involving gravitation within optical local relativity; that seems to have now become justified,—but as here urged when it is reconstructed into more consistent and Newtonian setting—by the astronomical tests, as the right type of mathematical formulation; in contrast with modes, one for example making use of a scalar gravitational potential in the fourfold, that might otherwise be in competition with it.

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[12] In a field of large uniform gravitational potential V_0 an increase of inertia of m_r depending on V_0/c^2 is simulated; but that point of view is confused. The Action is the sole arbiter, which here determines the total result of the field as orbital motions.

[13] When the approximation to the reduced Action for the Sun-Mercury system is carried to the second order, it appears that its form comes out of the type of the Newtonian Action for an elliptic orbit. If this is confirmed, then on the present theory there would be no influence on the secular progress of the perihelion: which, amid the astronomical complications, and in face of the smallness of the outstanding residue, can scarcely now be regarded as an unsatisfactory conclusion. The masses have to be predominantly intrinsic, as in the text.

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Tyndall's Experiments on Magne-crystallic Action.[1]

By Sir WILLIAM BRAGG, K.B.E., F.R.S.

IN 1845, Faraday made the surprising discovery that the vast majority of substances, not merely iron, nickel, and cobalt, are affected by a magnet: and showed also that the action is repulsive quite as often as attractive. Faraday's results excited the greatest interest and were the starting-point for many other researches. In fact, they paved the way for the work of Thomson and Maxwell, who came thereby to the establishment of the laws of electromagnetism. Among the many workers who followed Faraday was Tyndall, who made certain interesting discoveries relating to the behaviour of crystals in the magnetic field.

A very lively discussion sprang up as to the mode of interpretation of the new discoveries, particularly that of the so-called diamagnetism. On one hand, Faraday was satisfied that he could describe them in terms of his 'lines of force': the majority, including Tyndall, referred everything to the existence of poles, magnetic and diamagnetic. Tyndall's experimental work, and the consequences which he drew from it, were devoted to the support of these views. When Faraday's conceptions prevailed it became clear that Tyndall's interpretation of his own experiments must have been incorrect. His collected account of his researches, published in the well-known "Diamagnetism and Magne-crystallic Action," never became a link in the chain of argument.

The recent analysis of crystal structure by means of X-rays throws some new light on those experiments of seventy years ago. We can see more clearly where Tyndall's conclusions were in error. But at the same time the experiments of Tyndall are seen to be closely related to a modern research of immense importance, that of the effect of stress on the constitution and physical properties of materials.

FARADAY'S FIRST OBSERVATION OF DIAMAGNETISM.

On Sept. 13, 1845, Faraday made one of his most important discoveries, that of a relation between magnetism and light. He found that when plane polarised light was made to traverse a piece of his 'heavy glass,' a borosilicate of lead, in a direction coinciding with that of lines of magnetic force, the plane of polarisation was rotated. He had thus been successful in showing that the action of a magnet did not require the co-operation of a magnetic substance such as iron for its manifestation, but might be directly connected with a substance of a different kind, namely, glass, and a different activity, namely, light. In the following months he tried to find some other connexion between magnetism and this glass. He floated his glass on a liquid and tried whether he could move it by a magnet, without result. But on Nov. 4 he succeeded in his search.

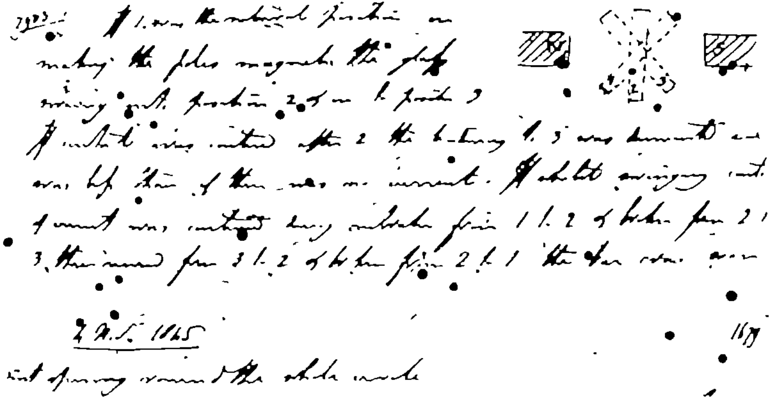

FIG. 1.—The above figure and a few lines of explanation are photographed from Faraday's original notes.

"The bar of heavy glass, $1\frac{7}{8}$ of an inch long and . . .[2] of an inch square, was suspended by cocoon silk in a glass jar in principle as before and placed between the poles of the last magnet. When it was arranged and had come to rest I found I *could* affect it by the magnetic forces and give it position. Thus touching diamagnetics by magnetic curves and observing a property quite independent of light by which we may probably trace these forces into opaque and other bodies as the metals, etc."

---

[1] Discourse delivered at the Royal Institution on Friday, Jan. 21.

[2] Not filled in, but from other notes we know it was half an inch square.

"If 1 was the natural position on making the poles magnetic the glass swung into position 2 and on to position 3. If contact was united after 2 the tendency to 3 was diminished, *i.e.* was less than if there was no current. If whilst swinging contact of current was continued during vibration from 1 to 2 and broken from 2 to 3, then united from 3 to 2 and broken from 2 to 1 the bar was soon sent spinning round the whole circuit," (see Fig. 1).

The word 'diamagnetic' is here used to denote substances through which, on his views, magnetic lines were passing. It is not yet used as an antithesis to 'paramagnetic.' His new result obviously gave him intense pleasure, and in following it up he was so preoccupied that he did not even go to the meeting of the Royal Society on Nov. 20 when his paper on the "Action of Magnets on Light" was read.

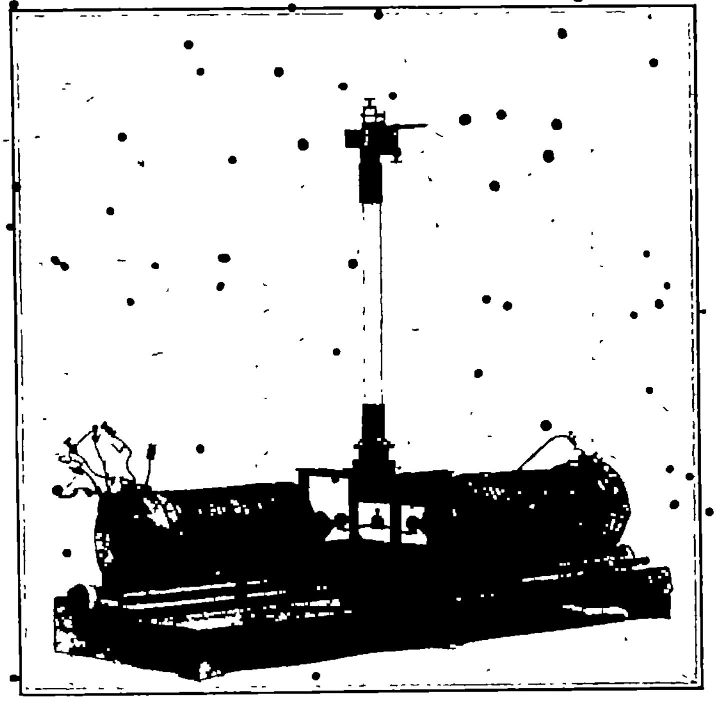

FIG. 2.—Apparatus used by Tyndall. Two balls of bismuth are placed at opposite ends of an arm swinging at the end of a suspension thread. The electromagnets are staggered so as to combine their actions in turning the arms by means of the repulsive forces exerted on the balls ("Diamagnetism and Magne-crystallic Action," p. 539)

We can easily repeat the experiment, using a piece of the same glass taken from the store left by Faraday. It is not the actual piece, Number 174, as he tells us in his notes, for this cannot be found. The glass turns slowly in the magnetic field, and its motions are obviously controlled by switching the current off and on. The glass tends to set itself *across* the lines of force running from pole to pole, not *along* the lines as a piece of iron would do; and obviously the effect is very small as compared with the violent movements of iron in the same circumstances.

The action may be described as a repulsion of the glass by the magnet: and sometimes the early workers on the subject constructed apparatus specially designed to show the repulsive effect more obviously, and to distinguish it from a mere turning action in a magnetic field, if indeed this could be done. We can illustrate this point, and at the same time the diamagnetism of bismuth, by using a piece of apparatus constructed for Tyndall (Fig. 2).

FARADAY'S FIRST EXPLANATION OF DIAMAGNETISM.

Faraday at first suggested that the diamagnetic effect was the antithesis of the ordinary magnetic effect. A piece of iron when placed between two poles became so magnetised that a south pole was developed upon it in that part which was nearest to the north pole of the inducing magnet and vice versa. Faraday's suggestion that the diamagnetic substance developed north and south poles where a magnetic substance would have developed south and north respectively was taken to be a satisfactory explanation. It was the constant endeavour of later experimenters to express their results in accordance with Faraday's hypothesis: even when development had reached a stage some distance ahead of that described in the original paper (*Phil. Trans.*, 1846, p. 21).

Faraday was himself the first to feel doubts as to the satisfactory nature of his explanation. His early results could conveniently be described as showing an exact antithesis between two classes; where one was attracted by a magnet, the other was repelled: where one set itself in a certain direction in the magnetic field, the other avoided that direction as much as possible. It seemed proper to describe them as being in exact antithesis to each other, and the word diamagnetism was adopted as a means of expressing the experimental result.

He prepared a list of substances which showed varying degrees of response to the action of the magnetic field, and the plan of the statement illustrates his first views ("Experimental Researches," Series xxi. No. 2424):—

“Iron
Nickel
Cobalt
Manganese
Palladium
Crown-glass
Platinum
Osmium
0° Air and vacuum
Arsenic
Æther
Alcohol
Gold
Water
Mercury
Flint glass
Tin
Heavy glass
Antimony
Phosphorus
Bismuth”

It is to be observed that those preceding air and vacuum are to be considered above zero or magnetic, those succeeding, below zero or diamagnetic, which is meant to imply a true antithesis.

In Dec. 1845 (“Experimental Researches,” Series xxi. No. 2429), Faraday writes :

> “Theoretically, an explanation of the movements of the diamagnetic bodies, and all the dynamic phænomena consequent upon the actions of magnets on them, might be offered in the supposition that magnetic induction caused in them a contrary state to that which it produced in magnetic matter; *i.e.* that if a particle of each kind of matter were placed in the magnetic field both would become magnetic, and each would have its axis parallel to the resultant of magnetic force passing through it; but the particle of magnetic matter would have its north and south poles opposite, or facing towards the contrary poles of the inducing magnet, whereas with the diamagnetic particles the reverse would be the case; and hence would result approximation in the one substance, recession in the other.”

Even at that time, however, Faraday's views were not firmly established : and we may repeat an experiment of his which shows the nature of the contrary influences that were impressing him. A small glass tube filled with a weak solution of the magnetic substance iron sulphate sets itself axially between the magnetic poles ; but if it is surrounded as it swings by a strong solution of the same substance, it sets equatorially. The tube appears to be magnetic as compared to air, but diamagnetic as compared to the strong solution.

Might not, on this analogy, all substances, and also air and vacuum, be magnetic, reacting to the magnet in the same way but to different degrees ? And might not bismuth exhibit its peculiarities, not because it is in antithesis to iron, but merely because it is less magnetic than the air ? Yet he writes as follows :

> “Such a view also would make mere space magnetic, and precisely to the same degree as air and gases. Now though it may very well be, that space, air and gases, have the same general relation to magnetic force, it seems to me a great additional assumption to suppose that they are all absolutely magnetic, and in the midst of a series of bodies, rather than to suppose that they are in a normal or zero state. For the present, therefore, I incline to the former view, and consequently to the opinion that diamagnetics have a specific action antithetically distinct from ordinary magnetic action, and have thus presented us with a magnetic property new to our knowledge” (“Experimental Researches,” Series xxi. No. 2440, Dec. 1845).

The extract describes his first-formed opinion.

PLÜCKER'S DISCOVERY OF MAGNE-CRYSTALLIC ACTION.

The next important step is due to Plücker :

> “In 1847, Plücker had a magnet constructed of the same size and power as that described by Faraday, his object being to investigate the influence of the fibrous constitution of plants upon their magnetic deportment; while conducting these experiments he was induced to try whether crystalline structure exercised an influence” (Tyndall, “Diamagnetism and Magne-crystallic Action,” p. 2).

The first experiment made by Plücker gave an immediate and decided reply. The investigation of the behaviour of several crystals led him to announce the following laws :

> “When any crystal whatever with an optic axis is brought between the poles of a magnet, the axis is repelled by each of the poles ; and if the crystal possesses two axes, each of these is repelled with the same force by the two poles.
>
> “The force which causes this repulsion is independent of the magnetism or diamagnetism of the mass of the crystal ; it decreases with the distance more slowly than the magnetic influence exerted by the poles.”

There is some truth in Plücker's conclusions, but much correction is necessary. Tyndall pointed out in 1850 that they broke down completely when applied to calcium and iron carbonate. These two crystals are isomorphous ; the former, Iceland spar, obeys Plücker's laws in that it sets its axis equatorially in the magnetic field, but iron carbonate sets its axis from pole to pole. Plücker had, however, done great service in directing attention to the peculiar behaviour of crystals in the magnetic field.

In the autum of 1848 Plücker was in London. Faraday writes in his laboratory notes :

> “16 Aug. 1848. Plücker has described to me certain of his results as to the crystalline diamagnetic relation and, as I understand it, the optic axis of a crystal having *one* optic axis tends to pass into the equatorial direction, or if a crystal have two optic axes then the line between them tends to pass into the equatorial direction.”
>
> “25 Aug. 1848. To-day Plücker showed me for the first time some of his experiments.”

“First Optical Results.

“A small rhomboid of Cal' Spar was suspended by a single cocoon thread between my Elect. Magnet poles with the optic axis in a horizontal position. When the poles were very close as in the figure the diamagnetic force of the substance made it take the position shown in which the optic axis is axial to the magnet. But when the poles were opened out to distance of half or threequarters of an inch, then the mass pointed axially and the optic axis therefore equatorially [see Fig. 3]. . . . There is a given distance between the Mag poles (pretty close) when a certain
of piece
rhomboid ∧ of Cal' spar between them is so affected that the diamagnetic and the magneto-optic force is balanced, at smaller distances the piece points diamagnetic and at larger distances Magneto optic. So that on increasing the distance the magneto-optic force diminishes *less rapidly* than the magnetic force, and on diminishing the distance it increases less rapidly than the magnetic force. *But increasing or diminishing the strength of the magnet produces no alteration of this place of neutral action, it only increases or diminishes the strength of the action on each side of it: or rather the resultant of the two actions on each side of that neutral position.* So Plücker at least tells me, for I did not see that proved.”

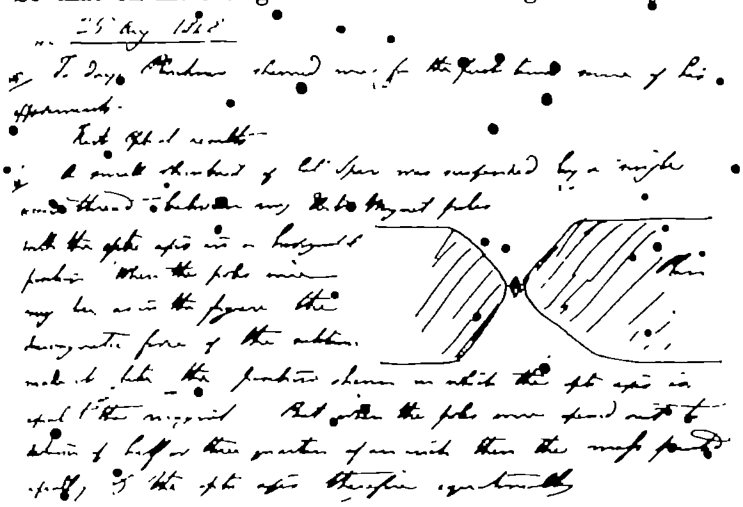
25 Aug 1848

Fig. 3.—The figure is taken from Faraday's notes, Aug. 25, 1848.

Plücker's experiment is readily shown; but a little care in adjustment is required. The dimensions of an equal-sided-rhomb are rather too much the same in all directions: a somewhat more irregular piece is, I find, easier to work with. The effect is much more clearly seen with a good bismuth crystal, which was obtained in the following way. A little bismuth was melted in a glass tube which had been drawn to a point. The tube was placed in an electric furnace, from which it was made by clockwork to emerge very slowly. The fine end of the tube came out first, and the bismuth at the point was the first to solidify into crystalline form. The rest of the metal crystallised slowly as the emergence proceeded, and, in the circumstances, continued the structure and orientation of the first fragment. In this way, due to Bridgeman, the mass contained large single crystals, not a mass of fine crystals as is usual when the solidification takes place rapidly.

When the crystal, which is ten times as long as it is broad, is placed in the magnetic field due to pointed poles, it sets strongly equatorially in accordance with the usual behaviour of a diamagnetic body: but when the poles are withdrawn somewhat, it sets axially with equal strength.

The experiments of Plücker introduced a new effect which Faraday afterwards called “magne-crystallic action.” It clearly deserved a name, since its manifestations added a complication to the diamagnetism which had already been observed.

The new discoveries presented so many forms when repeated with different crystals suspended in different ways and with different forms of magnetic field that the complications were not unravelled for some years. Some of the difficulties were due to the circumstances of the experiments and had no relation to the real question. One of these incidental effects was that of attractions and repulsions due to transient currents induced in bodies already suspended for observation between the magnetic poles when the magnets were excited. As is well known, the motion of a spinning block of copper is at once arrested by the action of such currents; on the other hand, a sheet of copper held near a pole is sharply repelled when the current is turned off, and if properly suspended can be set into a rapid spinning. These effects had nothing to do with diamagnetism, but they were apparently the cause of confusion on some occasions.

Another great source of difficulty was the overpowering effect of iron impurities; the diamagnetic effects are so feeble in all cases that a mere trace of iron, nickel, or cobalt is sufficient to mask them. So, for example, Plücker's experiments with antimony seem on this account to have been at variance with the true facts as proved by Faraday (Tyndall, p. 16).

FARADAY'S RESEARCHES ON MAGNE-CRYSTALLIC ACTION.

In 1848, Faraday published a series of researches on the magne-crystallic phenomena, which cleared up some of the difficulties. But in 1850 he could still write as follows:

"Four years ago I suggested that all the phenomena presented by diamagnetic bodies, when subjected to the forces in the magnetic field, might be accounted for by assuming that they then possessed a polarity, the same in kind as, but the reverse in direction of, that acquired by iron, nickel, and ordinary magnetic bodies under the same circumstances. This view was received so favourably by Plücker, Reich, and others, and above all by W. Weber, that I had great hopes it would be confirmed; and though certain experiments of my own did not increase that hope, still my desire and expectation were in that direction. (2641) Whether bismuth, copper, phosphorus, etc., when in the magnetic field are polar or not is, however, an exceedingly important question; and very essential and great differences in the mode of action of these bodies under the one view or the other, must be conceived to exist. I found that in every endeavour to proceed by induction of experiment from that which is known in this department of science to the unknown, so much uncertainty, hesitation, and discomfort arose from the unsettled state of my mind on this point that I determined if possible to arrive at some experimental proof either one way or the other. This was the more important because of the conclusion in the affirmative which Weber had come to in his very philosophical paper. . . . (2642) It appeared to me that many of the results which had been supposed to indicate a polar condition were only consequences of the law that diamagnetic bodies tend to go from stronger to weaker places of action; others, again, appeared to have their origin in induced currents. . . ."

Accordingly, he undertook a further series of researches which in the end brought him to regard all his effects as expressible in the simple form with which we are familiar. In his "Experimental Researches" he writes (Ser. xxvi., Oct. 1850, No. 2807):

"When a paramagnetic conductor, as for instance a sphere of oxygen, is introduced into such a magnetic field considered previously as free from matter, it will cause a concentration of the lines of force on and through it so that the space occupied by it transmits more magnetic power than before. If, on the other hand, a sphere of diamagnetic matter be placed in a similar field it will cause a divergence or opening out of the lines in the equatorial direction, and less magnetic power will be transmitted through the space it occupies than if it were away" (see Fig. 4).

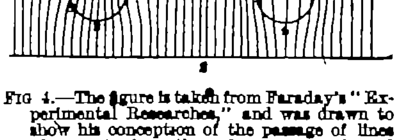

FIG 4.—The figure is taken from Faraday's "Experimental Researches," and was drawn to show his conception of the passage of lines of magnetic force through paramagnetic and diamagnetic bodies respectively.

This describes diamagnetism generally; the complication of magne-crystallic action is described with equal simplicity:

"(2837) If the idea of conduction be applied to these magne-crystallic bodies it would seem to satisfy all that requires explanation in their special results. A magne-crystallic substance would then be one which in the crystallised state could conduct onwards, or permit the exertion of the magnetic force with more facility in one direction than another: and that direction would be the magne-crystallic axis. Hence, when in the magnetic field, the magne-crystallic axis would be urged into a position coincident with the magnetic axis by a force correspondent to that difference, just as if two bodies were taken, when the one with the greater conducting power displaces that which is weaker."

It is only a uniaxial crystal, of course, which possesses a single magne-crystallic axis; it is the axis of a certain spheroid. The facility of conduction in different directions in a biaxial crystal requires an ellipsoid for its representation.

This way of stating the rules allows us to see at once the principle of the experiments shown by Plücker to Faraday, which the latter so greatly extended. When the magnet poles were close, the crystal occupied a part of the field where the lines of force were very divergent. In such circumstances the orientation of the crystal would be determined by the general tendency for diamagnetic bodies to move from the stronger to the weaker parts of the field, and the crystal set its longer dimension perpendicular to the field; the optic axis was then parallel to the lines of force. But when the magnetic poles were separated the crystal covered a part of the field in which there was little divergence: the magne-crystallic action then took charge, and the crystal set itself so that the direction of worst conduction of the lines, *i.e.* the optic axis, was at right angles to the lines.

Experimental Illustration of Magne-crystallic Action.

A few simple experiments will serve as further illustration of these rules. We take a crystal of sulphate of iron which has the form of a thin plate: the flat sides are cleavage planes and the 'conducting power' for Faraday's lines is far greater across the plate than along the large faces. In a uniform field the crystal plate sets equatorially therefore, and even when allowed to move up to one of the poles keeps its face normal to the lines. A thin plate of iron would stand on edge on the pole: but the magne-crystallic action of this paramagnetic crystal is exceedingly strong.

A bismuth crystal so suspended that its axis (it is a uniaxial crystal) is vertical has no magne-crystallic action. Its motions are governed by the general tendency of its mass to move from the stronger to the weaker parts of the field: in a uniform field it has no appreciable tendency to set itself in any particular direction. But when the crystal is hung so that the axis is horizontal, that axis tends strongly to set itself along the lines of force, as we saw before.

Naphthalene is a monoclinic crystal. Its magne-crystallic properties are represented by an ellipsoid, one axis of which coincides with the single axis of symmetry. The cleavage is very perfect and the crystals take the form of thin plates parallel to the cleavage planes. The axis is also parallel to the cleavage planes, and if the crystal is suspended so that this axis is horizontal and the cleavage planes vertical, the axis and the planes move into the equatorial position, in this way fulfilling symmetrical considerations. But when the crystal is hung in a uniform field, so that the axis is vertical, the cleavage planes set themselves at a certain angle to the field. One of the axes of the magnetic ellipsoid then lies along the lines, another across them: the third is vertical. There is no obvious relation between the cleavage plane and the first two axes. Finke (*Annalen der Physik*, 31, 149; 1910) has shown that this may be said of various crystals examined by him. If now the crystal be suspended from the other end of the axis, its cleavage planes will make the same angle with the field but on the opposite side of the medial line (Fig. 5). Faraday describes results of this kind which he obtained with a paramagnetic crystal of sulphate of iron ("Experimental Researches," Series xxi. Nos. 2634-7). Naphthalene is diamagnetic: like many other organic crystals, it shows the magne-crystallic effect very strongly.

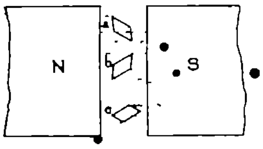

FIG. 5.—In this figure the positions marked *a* and *b* are positions of equilibrium of the naphthalene crystal in the magnetic field. The axis of symmetry is vertical and perpendicular to the plane of the paper. The cleavage plane is also vertical and its intersection with the plane of the paper is the longer side of the rhomboid. The form of the crystal shown in the figure is not a natural form, because the shorter side of the rhomboid is drawn parallel to one face of the cell of the crystal lattice, which face does not usually occur on the crystal. It is so drawn in order to show the relation between magnetic lines and the lattice.

If the crystal is hung from one end of the *b* axis, the position *a* is assumed, and if from the other, the position *b*. The position *c* is impossible.

These experiments will serve to show the great variety of effects that may be observed. All of them are, however, easily correlated by Faraday's conception of lines of force. Let us remember that there are several variables and give due importance to each. The first of these we call diamagnetism, implying that the lines pass through the substance in question less easily than through the air or a vacuum. The second is called magne-crystallic action, in reference to the fact that in a crystal the lines pass more easily in one direction than another. A third variable is the crystal shape, which may also affect the set in the magnetic field when the latter is divergent. A fourth is the amount of divergence of the field which, in a uniform field, falls to zero. After experimental disturbances have been allowed for, all these influences have to be taken into account.

The more divergent the field the more does the simple diamagnetic effect assert itself, and any magne-crystallic action which would tend to make the specimen set a crystal axis or axes at some particular inclination to the direction of the field is overpowered.

THE CONTRAST BETWEEN PARAMAGNETISM AND DIAMAGNETISM.

On the other hand, magne-crystallic action usually takes charge in a truly uniform field. For the sake of brevity and an easier explanation, it may be well to direct attention to a fact which was not fully appreciated by all the first experimenters, but was clearly set out by Sir William Thomson (Lord Kelvin) in 1885. A diamagnetic bar, apart from magne-crystallic action, tends to set itself *along* the lines of force in a *uniform* field, just as a paramagnetic bar. For we may imagine the bar to be made up gradually of a collection of cubes, placed successively one after the other in the magnetic field. The effect of the first cube is, as we should say in the language of Faraday, to spread out the lines of force on their way through the cube, and to crowd them together on either side of it. A second diamagnetic cube will, if free to move, go to that part of the field where the lines are least crowded; it will therefore avoid setting itself beside the first cube and prefer to place itself in front or behind it. A third will continue the same process, and in the end the cubes will form a bar pointing along the lines. In the case of a substance such as iron, there is a double converse.

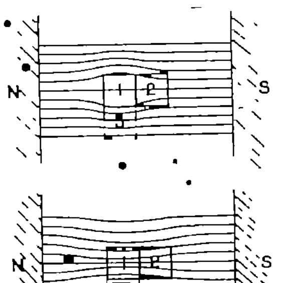

FIG. 6.—Dia- and paramagnetic substances in a magnetic field. In both cases Position 2 is preferred to Position 3.

The lines are most dense just in front and just behind the first cube; and a second cube will place itself in one of those positions because a magnetic substance seeks the strongest part of the field. Again, therefore, the bar grows along the lines, as in this case we know from experience (see Fig. 6).

It is quite certain that no one has ever seen the first of these effects, because it must be so minute and difficult to separate from others. We may safely infer it, as Thomson pointed out, because our theories of the electromagnetic field have been abundantly justified by other means. The susceptibility of bismuth, by far the most diamagnetic substance, is only about 10^{-6}; in other words, the strength of the field on one side of a bismuth cube of 1 cm. side would only be about a thousandth part of 1 per cent. greater than at the front or back of the cube. Near a pointed pole the strength of the field might easily vary by 50 per cent. in a centimetre. It is easy to see how feeble is the force tending to arrange the supposed cubes parallel to the lines of a uniform field as compared with the forces acting on a bar placed near the pole.

The analogous effect in electrostatics can, however, be realised. When two plates are immersed in oil and maintained at a large difference of potential, an elongated rod of glass hung from a fibre sets itself along the lines of force (to make sure that the effect is true the rod must be free from any conductivity due to its own substance or a water film). This corresponds to the setting of a magnetic body in a uniform field. When bubbles of air are allowed to rise through the oil they are drawn out along the lines of force; which effect, since the inductivity of air is less than that of oil, represents the setting of a diamagnetic body along lines of magnetic force.

When a diamagnetic substance sets itself across the lines of a magnetic field, and no magne-crystallic action is at work, it is because the field is not really uniform. It is perhaps a little confusing when it is said, as is sometimes the case, that diamagnetic and paramagnetic substances are the antitheses of one another in that one kind sets itself across the field and the other along it. This is only true of a field which is non-uniform. Indeed, it may be said that the use of the word antithesis is incorrect in any case. There would be a true antithesis if one substance could be defined by its pointing along the lines of force in one direction while another pointed in exactly the opposite direction; there is no true antithesis between pointing along the lines and pointing across them. It seems to me, though I say it with diffidence, that this difficulty was stirring in Faraday's mind and was the true cause of the uneasiness of which he spoke in a quotation given above, and of his aversion to the description of diamagnetism and paramagnetism as being the antitheses of one another.

Faraday, as I have said, when this thorough examination of the facts had led him to frame a hypothesis which would link them together, based his interpretation on the existence of lines of force, and found himself able to place both his own results and those of others in their place within a self-contained system.

Kelvin placed this hypothesis in mathematical form, thus completing the treatment of the subject of magnetism by Poisson; the latter had left out of his consideration the consequence of magnetic susceptibility being different in different directions, not because he overlooked the possibility of such an effect, but because no case of its occurrence was known to him.

THE HYPOTHESIS OF POLARITY.

Faraday's views were not accepted, however, by other experimenters on the same subject, and in particular by Tyndall.[*] The idea of polarity was not to be given up easily, and innumerable experiments were made to show that a 'diamagnet' had poles like a magnet, but in the opposite sense. A bar of bismuth would develop north and south poles when, in similar circumstances, a bar of iron would develop south and north. Of course, when the facts are prepared for mathematical treatment, they can be expressed in this way. It is generally convenient and justifiable to represent a magnet by two poles because the form of the field at any reasonable distance is satisfactorily represented thereby, though in the immediate neighbourhood the lines of a real magnet do not run like those of the theoretical bipole. Within the body of the magnet the lines run from the south pole to the north, continuing and completing their course outside so that every line is a closed circuit; but all lines near a bipole run from the north pole to the south pole. So also in the magnetic shell, which is in the mathematical treatment the exact analogue of the electrical condenser, the bulk of the lines run from one plate to the other across the narrow space between the two plates; comparatively few run from the outside of one plate, through surrounding space, to the back of the other. In the condenser, the internal field is the most important, the external being looked on as a correction. In the magnetic shell the reverse is the case; the outside field is that which is considered because it represents more and more closely, as the plates are brought closer together, the field due to a current circulating about the contour of the condenser. The theoretical charges on the plates have to be made larger and larger as the plates are brought together, so that the strength of the outside field may remain the same.

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[*] My authority is Capt. Dunsheath of the Henley Telegraph Works Co.

Now, if a piece of bismuth is placed along the lines of a magnetic field, the lines avoid the piece to some extent, though, as already explained, the avoidance is extremely small. If we take the bismuth away and replace it by a feeble bipole consisting of south-pole magnetism, of proper amount, where the lines come out of the bismuth, and a corresponding amount of north-pole magnetism where they go in, the whole arrangement being made in a vacuum, or permissibly, in the air, we get (Fig. 7) in this artificial way an external field resembling that which exists when the bismuth is in place. It can be said that polarity is developed in the bismuth in a sense opposite to that which is found in iron in the same circumstances. If the effect is to be represented, for the convenience of treatment, as due to the presence of a bipole, then the sense of the bipole in the case of bismuth is opposite to the sense in the case of iron. The old argument, therefore, was not between two hypotheses but between two languages in terms of which the facts were to be described. Such an antagonism, once believed in and debated, could be and was the cause of an immense variety of experiments devised to justify one side or the other. But Faraday felt that his way of putting the facts was more fruitful in suggestion of further experiments, and more convenient as a foundation for theoretical development. He has been abundantly justified.

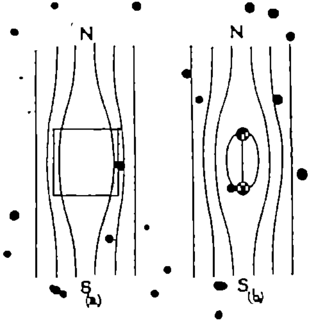

FIG. 7.

THE WORK OF TYNDALL AND KNOBLAUCH.

We now come to the part which Tyndall played in a debate which was conducted on both sides in such an able and, it is pleasant to observe, in such a friendly way. In the first place, Tyndall and Knoblauch published in 1850 an account of experiments which they had made. They showed that Plücker's first views, those which included the repulsion of the optic axis of a uniaxial crystal by the poles of the magnet, were, as already stated, incorrect in many cases, and they substituted an amended set of rules in the following terms:

> "If the arrangement of the component molecules of any crystal be such as to present different degrees of proximity in different directions, then the line of closest proximity, other circumstances being equal, will be that chosen by the respective forces for the exhibition of their energy. If the mass be magnetic this line will set axial; if diamagnetic, equatorial."

The key-word is "proximity." This condensed statement of course requires explanation. Tyndall supplies it in full in his book on "Diamagnetism and Magne-crystallic Action." A very brief summary will be sufficient for our present purpose. In the first place, the observations made by him and his partner on the behaviour of crystals in the magnetic field convinced them that the plane of cleavage determined in a number of cases the position which the suspended crystal would take. Magnesium sulphate, zinc sulphate, saltpetre, and topaz were diamagnetic substances, and their cleavage planes, the crystals being so suspended that these planes were vertical, always set themselves equatorially, *i.e.* at right angles to the field. On the other hand, nickel sulphate, scapolite, and beryl, which were magnetic crystals, in the same circumstances set their cleavage planes parallel to the field.

The connexion between these results and the statement quoted above lies in this, that the molecules in a crystal were supposed to be in greater proximity along a cleavage plane than in any other direction. Let us take bismuth as an example; it is diamagnetic and sets its cleavage plane equatorially in accordance with Tyndall's rule. Its structure has now been determined by X-ray analysis, so that we can see what meaning can be attached to the claim for proximity in the plane of cleavage. The bismuth structure can be looked on, approximately, as a slightly distorted cube; one of the cube's diagonals has been a little stretched, while the other three have been left unchanged. The crystal is therefore uniaxial; the axis is the stretched diagonal. The principal cleavage plane is perpendicular to the axis. The spacing of the planes parallel to the cleavage is larger than that of any other set of planes in the crystal, and these consequently contain more molecules to the unit area than any other planes. Tyndall would have said that in those planes there was a maximum proximity between the molecules.

The X-ray analysis of other crystals often shows the cleavage plane to have the largest spacing and therefore the closest degree of packing. This means that the points of the crystal lattice are closest together in that plane, but it does not mean that the atoms or molecules are nearer together in that plane than in any other. Nothing can be said about that until the actual distribution of the atoms in the unit cell has been determined. It would be much safer to say that the existence of a cleavage plane implies a certain *looseness of packing across* the crystal planes which are parallel to the cleavage. This would imply a greater tightness in other directions, but not necessarily a greater proximity. It is only at first glance that the latter term seems to have a clear meaning. But we must let it stand in order to realise the argument as it presented itself to the authors of the statement quoted.

It happens that in the case of bismuth we do actually find a closer bonding between the atoms in the cleavage plane than in any other; but this is peculiar to the structure of bismuth and has no relation to the supposed close proximity of *molecules* in the cleavage plane.

Now we come to the essential point of the argument. It is supposed that proximity offers magnetism or diamagnetism, whichever it may be, the opportunity to "exhibit its greatest energy." We are to remember that the hypothesis on which we are working expresses itself in terms of poles and that a magnet attracts a piece of iron by inducing poles in it, which poles then react with the poles of the magnet. When a piece of iron is allowed to attach itself to a magnet, the poles induced in it are much stronger than if the magnet and the iron are separated by a little distance. If a second piece of iron is brought near the first, every increase in its proximity increases the strength of the poles which are developed in this piece by the influence both of the original magnet and of the first piece of iron.

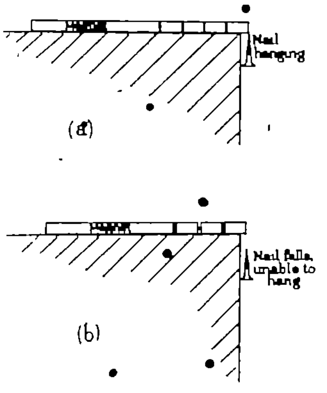

FIG 8.—When pieces of iron are all in contact with one another and the end one with the magnet, the nail can hang as shown in (*a*). But when, as in (*b*), the iron blocks are somewhat separated from one another and from the magnet, the nail falls.

A simple experiment will serve as an illustration (Fig. 8): The nail hangs in the first case, and not in the second, because the close proximity of the iron blocks increases the strength of the poles in all of them. In the second case, the nail will not hang, although the magnet is actually closer to it. The benefit of mutual 'proximity' of the separate pieces of iron is obvious. An equally simple explanation can be given in terms of lines of force, but we are using the alternative language.

Chains of iron fragments form readily between magnet poles of opposite nature. A rod of iron "transmits the magnetic force," and generally acts more efficiently than a set of iron fragments which are not allowed to get into close proximity with each other. Tyndall sticks short lengths of iron wire through disc-shaped pieces of apple and shows that the disc sets itself at right angles to the field, the bits of wire therefore lying parallel thereto. In each bit are many molecules of iron in close proximity, and the fact is more effective in directing the apple than the existence of a number of bits scattered over the disc without being in 'proximity' to each other.

Diamagnetism and 'Proximity.'

It is now argued by Tyndall that if the magnetic influence of a magnet is extended by means of proximity, the diamagnetic influence must be extended in the same way. If the close proximity of iron fragments will help them to set with greater firmness in the direction joining opposite poles, then the closer proximity of bismuth fragments should cause them to set with greater firmness across them. In this way Tyndall interpreted the rule, which he believed he had established, that the cleavage planes of magnetic crystals tended to set axially, and those of diamagnetic crystals equatorially.

It is interesting to observe that Tyndall was attempting to supply both a rule for the setting of crystals and an explanation of the rule in terms of structure. Faraday stopped short when he had supplied a picture of the distribution of his magnetic lines, or, as we should now say, a map of the distribution of energy in the magnetic field.

As I have already pointed out, there is no clear meaning to the term "greater proximity in the cleavage plane." Moreover, if conclusions were to be drawn from analogy with phenomena on a larger scale, they would run contrary to the intended argument; for, on that scale at least, a line of diamagnetic masses tends to set itself axially, not equatorially. A piece of bismuth makes an extremely minute alteration in the disposition of the lines of force, for which reason it is a very poor detector of the existence of the lines in comparison with iron; and the change, since it is so small, can indeed be detected by a piece of iron in the form of a magnet, but certainly not by another piece of bismuth, no matter how close they are together.

In the case of a uniaxial crystal, a principal cleavage must from symmetry considerations be related to the axis, and, if it is unique, must be perpendicular thereto. When there is more than one cleavage, the cleavage planes must be symmetrically disposed about the axis as in the case of Iceland spar. It is not, therefore, surprising that, in the former case, the cleavage plane should place itself exactly, either equatorially or axially, and that in the latter case a plane perpendicular to the axis might be looked on as a resultant of cleavage planes and therefore set itself equatorially. But it does seem remarkable that, as Tyndall pointed out, the substitution of iron for calcium in Iceland spar, to form the isomorphous iron carbonate, should turn the structure round through 90° in the magnetic field; especially if we assign diamagnetism and paramagnetism to different causes. It may be there are other cases of the same change; and any rule of this kind must clearly be of importance.

THE EFFECTS OF PRESSURE ON MAGNETIC SUSCEPTIBILITY.

We now come to another set of experiments, very interesting and important, which were used by Tyndall in the defence of the 'polarity' position. The method of these experiments was suggested by an accident. When working in Berlin with a fine magnet placed at his disposal by Magnus, he was observing the action of the magnet on a bismuth cube which was so shaped that two opposite faces were perpendicular to the optic axis and parallel to cleavage planes. When the current was switched on, the magnet poles rushed together because the separate parts of the magnet had not been properly bolted down. The bismuth cube was crushed to some extent. Working conditions having been restored, it was found that the bismuth set itself at right angles to its former position. The line of pressure, which, of course, had been parallel to the field, was now perpendicular to it. Tyndall now argued that the particles of bismuth had been brought into greater proximity by the pressure and that the setting of this line of great proximity was in accordance with the rule given by himself and Knoblauch. So began an extended series of researches on the effects of pressure which are fully described in his book. As an example let us take the following:

"A quantity of bismuth was ground to dust in an agate mortar, gum-water was added, and the mass was kneaded to a stiff paste. This was placed between two glasses and pressed together; from the mass when dried two cubes were taken, the line of compression being perpendicular to two of the faces of each cube and parallel to the other four. Suspended by a silk fibre in the magnetic field, upon closing the circuit the line of compression turned strongly into the equatorial position. . . ."

When carbonate of iron was used, the line of pressure set axially.

Such an experiment is very striking, whatever its explanation may be. Tyndall argued that he had by compression increased the proximity along the line of pressure, but it is difficult to see how this can be. If a number of particles of one kind are distributed with complete irregularity in a paste medium which is then subjected to pressure in one direction, the alteration in form of the paste block will not alter the law of distribution of the particles. In any case, as we have already seen, proximity does not produce any observable effects.

LORD KELVIN'S EXPLANATION OF TYNDALL'S RESULTS.

It is surely natural to suggest that the particles acquired some orientation from the pressure, which might well happen if they possessed shapes which were related in some particular way to their structures. Thomson immediately pointed this out to Tyndall, who replied that if that were the case, the bismuth fragments being naturally in the form of flakes parallel to the cleavage plane, the line of pressure ought therefore to set itself axially, whereas it actually set equatorially. This was certainly a good reply. Perhaps the counter argument is that the crystal fragments have not actually been shown to set in this way. Miss Knaggs has made an X-ray measurement of the set of the fragments in one specimen of squeezed dough containing bismuth particles, and has found that the cleavage planes are not closely coplanar with the surface, as they must be if Tyndall's argument is to be good. Though this is a single example, it looks as if a way of escaping the difficulty was to be found.

As I have said, Tyndall's reply to Thomson was good, but, to use his own words, though it formed "a strong presumptive argument it was not yet convincing" He strengthened his case greatly by a further experiment. Comparing the repulsion exerted by a magnet on a natural crystal of bismuth with that exerted on a mass of compressed powder in dough, he found the latter greater than the former. He had cut the crystal into the form of a cube and placed it on one arm of a torsion balance so that the cleavage plane was perpendicular to the magnetic field, and the repulsive force as great as it could possibly be. The dough had been pressed into a cube of the same size and placed with its line of pressure at right angles to the field. Tyndall argued that there must be a direct effect of pressure, since it had done more than all that the natural phenomena could do.

Now it is clear that if the orientation of a bismuth crystal in a uniform magnetic field, *i.e.* the magne-crystallic action, is due to the arrangement of the atoms and molecules in the crystal structure, the perfect crystal ought to show the effect more perfectly than the fragments distributed through the dough, however perfectly the latter may be arranged. But Miss Knaggs has made an X-ray photograph from the face of a natural 'crystal.' The specimen was chipped out of a mass of crystals left in a crucible, and must have resembled that which Tyndall used. The photograph showed at once that the specimen was a compound of more than one crystal, and that different orientations were present. Cleavage planes, and also others which in a single crystal would make large angles with the cleavage planes, were nearly parallel to the face under test. It is possible, therefore, that there was really more of the effective orientation in the pressed specimen than in the natural piece. A photograph of the single crystal made by Bridgman's method taken in the region of the cleavage plane gave a much clearer picture.

A piece of bismuth can be looked on as an aggregate of crystals. There may be but one perfect crystal or there may be a number, small or large, of smaller crystals, each perfect. If proximity were increased by pressure, the change in proximity would have to occur in respect to the mutual distances in either of the separate crystals, or of the atoms and molecules in the single crystal. The X-ray analysis shows that the latter alternative is impossible, because from many tests recently carried out in respect to metal structure, we learn that no permanent change in the crystalline lattice is occasioned by stress. The former alternative is also ruled out, because, as Faraday pointed out,[4] bismuth is actually of a lower density after compression than it was before; the pressure having of course been removed. Apparently the breaking up of the specimen increases the extent of the cavities.

Tyndall made many paste models of crystals, mixing powders of bismuth, carbonate of iron, or other active substances with flour and water, or gum. He pressed the mass by different amounts in different directions and then cut it to shape; in this way he imitated the magne-crystallic action in detail. At one time, in order to meet the objection that he was merely rearranging the small crystals in his paste and conglomerates, he took some white wax "concerning whose amorphism there can be but little doubt." The substance is diamagnetic. A little cylinder of the wax, suspended in the magnetic field, set with its axis equatorial. It was then placed between two stout pieces of glass and squeezed as thin as a sixpence; suspended from its edge, the plate thus formed set so that its length, which coincided with the axis of the previous cylinder, was axial and its shortest dimension equatorial. But we know now that wax is anything but amorphous; its crystalline structure has not only been observed but also accurately measured; and we know also that pressure arranges the orientation of the crystals.

Tyndall obtained the same result with a piece of bread, and we may repeat the experiment. A small piece of the crumb is squeezed between two glass plates, and the edges of the irregular mass are trimmed off, so as to leave a thin disc. When this is suspended so that its plane is vertical, it sets equatorially if the poles are close together and the field is very divergent. It is therefore diamagnetic. But when the bread is moved from the space between the poles to a more uniform part of the field, the plane of the disc turns through a right angle and sets itself parallel to the lines of force. It is quaint to observe how the bread, as it is moved up to the poles, sets itself to pass neatly through the narrow gate and take up a parallel position on the further side. This is due to magne-crystallic action, so that the bread contains crystals, a fact easily verified by X-ray methods.

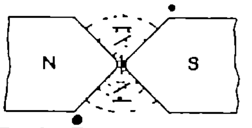

FIG. 9.—The black lines show different positions of a thin wafer of pressed bread hung by a single fibre. In the outer parts of the magnetic field it sets more or less along the lines, but as it is brought up to the more intense parts, where there is great divergence of the lines, it turns so as to set itself at right angles to the field.

THE EFFECTS OF PRESSURE ON CRYSTALLINE CONDITION.

The long series of interesting and ingenious experiments which Tyndall made to show that pressure produced proximity and proximity produced the equivalent of magne-crystallic action, must be held to have failed in their original purpose. But they will doubtless be put to a different use.

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[4] His reference was to "Gmelin's Handbook of Inorganic Chemistry," vol. 4, p. 428.

They are related to a subject of immense importance in these days, namely, the effects of pressure and tension and mechanical treatment generally, upon the state of a material and upon its physical properties. The consideration of such questions is fundamental to metallurgy and to other industries. The microscope has for many years been employed for the purpose, and the new methods of X-ray analysis are already being put into service. It may well repay us to consider Tyndall's experiments in a new light; and to examine the actual nature of those rearrangements which produced such remarkable changes in magnetic reactions. Tyndall himself discussed the effects of pressure in producing planes of possible cleavage, and was one of the pioneers in showing how such planes, occurring in the earth's crust, were not always to be interpreted as the result of sedimentary deposition, but rather of pressure, which might, if it were exerted more or less along the deposition planes, produce cleavages across the latter. He extended the principle to account for stratification in rolled materials, even in biscuits and pastry!

Faraday's use of lines of force did not, in reality, demand so much framing of hypothesis as Tyndall's polarity. It is to be observed that, as Faraday pointed out, they had no differences about facts, merely about methods of description, which methods, however, were of different value as suggesting development. To Faraday's conceptions have been added theories of magnetism and diamagnetism based on the existence of resistanceless molecular circuits as imagined by Ampère and Weber, or on revolving electrons as explained by Langevin. In the most recent times the quantum theories have again modified our ideas.

MODERN CONSIDERATIONS.

The crude hypothesis of the molecular circuit leads simply to a useful point of view of the difference between paramagnetism and diamagnetism, and the most modern discussions, though they differ greatly in appearance, leave that point of view almost untouched. If any of Faraday's lines of force thread a circuit which has no electrical resistance, that number can never be changed. If, therefore, a substance be brought into a magnetic field, the molecular circuits in the atoms of the substance act like obstructions to the lines; and the total obstruction, of which the negative magnetic susceptibility is a measure, is proportional to the sum of the areas of all these circuits, as projected on a plane perpendicular to the lines. It is of no consequence whatever whether there are already currents in those circuits; unless, indeed, the circuits are movable and c[illegible] their set towards the imposed field. Thus the diamagnetism is unaffected by the existence of molecular magnetic fields; or by any changes in them, so long as the total of the projected areas of the circuits is unchanged.

This result does not hold if circuits approach each other so closely that they offer less obstruction to the lines than if they were more separated. Two resistanceless circuits running closely parallel to each other offer little more opposition to the passage of lines than either circuit alone. We should imagine that such changes in the relative position of circuits would only occur in strenuous circumstances such as, possibly, those of crystallisation. It is known that diamagnetic susceptibility may vary very slightly: for example, Oxley has shown that crystallisation sometimes brings about small but definite alterations. As has often been pointed out, this simple theory makes diamagnetism a property of all substances, which can be affected, even overwhelmed, when the circuits already contain currents, and therefore can be orientated afresh by the magnetic field.

Let me say in conclusion that although recently acquired knowledge of the structure of materials leads us to reconsider Tyndall's experimental results, we are still far from the full explanation of the connexion between structure and magnetism, and of the influence of the latter upon physical properties.

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The Prediction of Eclipses.

By Dr. L. J. Comrie.

THE fact that astronomers can predict, many years in advance, the time of a solar eclipse to within a few seconds, and the region on the earth's surface in which it will be visible to within a mile or so, will perhaps surprise the layman. Yet attention was directed to the forthcoming eclipse of June 29 more than half a century ago by the Rev. S. J. Johnson in his "Eclipses Past and Future."

These advance predictions are possible because eclipses pass through a definite cycle, or repeat themselves after an interval of 18 years 11⅓ days. To explain the reason for this, consider the conditions that lead to an eclipse. It is well known that the earth moves round the sun in a nearly fixed plane called the ecliptic. As seen from the earth the apparent motion of the sun in the heavens is along the great circle which represents the intersection of the ecliptic plane and the celestial sphere, or the ecliptic circle. If the motion of the moon round the earth were in the same plane, then once in every lunar month of 29½ days the moon would be in line with the sun, and an eclipse would result. Actually the plane of the moon's orbit is inclined to the plane of the ecliptic at an angle of 5°. This means that the great circle representing the moon's orbit crosses the ecliptic at two opposite points or nodes, while half-way between the nodes the nearest possible approach of the two bodies is 5°.

Should the sun happen to be within a certain limiting distance from either of these nodes at the time the moon crosses the ecliptic, there will be an eclipse, either partial or total. If the nodes remained fixed on the ecliptic, eclipses would take place at the same two seasons each year. Actually the nodes make a complete circuit of the ecliptic in a backward or retrograde direction in a little less than nineteen years, so that the sun, in its annual course through the ecliptic, returns to the same node, not in 365·24 days, but in 346·62 days, a period called the eclipse year. Nineteen of these periods equal 6585·78 days. The interval between successive conjunctions of the sun and moon, or, in other words, the interval between successive new moons, is called the synodical month, and is 29·53 days. 223 of these lunations contain 6585·32 days. That is to say, if the sun and moon at any given moment are in conjunction at or near a node, so that an eclipse is in progress, then after 6585·32 days they will again be in conjunction and in the immediate neighbourhood of a node, so that another eclipse will occur.

The circumstances of an eclipse vary considerably with the distance of the moon from the earth—from an annular eclipse when the moon is at its maximum distance of about 257,000 miles to a long total eclipse of perhaps six or seven minutes' duration when the distance is as small as 223,000 miles. The interval between successive returns to the same distance from the earth, or the anomalistic month, is 27·55 days, and 239 of these intervals are 6585·54 days. Thus not only is there a repetition of the eclipse after 6585 days, but also it will occur under practically the same conditions.

This most useful period of recurrence was known to the Chaldeans as the Saros, and formed the basis of their very successful eclipse predictions. It is still used for the purpose of fixing the dates on which eclipses will occur, although the details of the eclipses are obtained by more refined methods.

One question must be answered. Why was not a total eclipse visible in England eighteen years ago, in 1909? The reason is that 223 lunations exceed 6585 days by about 8 hours, and in that time the earth has rotated, so that successive corresponding eclipses occur, on the average, 120° of longitude farther to the west.

Mention should be made here of Oppolzer's celebrated "Canon der Finsternisse" (Vienna, 1887), which gives particulars of all eclipses between 1207 B.C. and A.D. 2161, together with maps showing the central lines of total eclipses. An inspection of these maps indicates that the eclipse of 1999 will be total in Cornwall only, and that the next total eclipse visible in England in 2135 is the first of a group of four that will be seen in the course of 25 years, namely, in 2135, 2142, 2151, and 2160.

The accurate prediction of a solar eclipse is dependent ultimately on accurate predictions of the positions of the sun and moon. These bodies have been carefully observed with meridian circles for more than two centuries. The principal object in founding the Royal Observatory at Greenwich was the making of these observations, and to this day unrelaxing efforts are made to observe every meridian passage. In the hands of those masters of celestial mechanics, Delaunay, Hansen, Leverrier, Newcomb, Hill, and Brown, these observations and Newton's gravitational theory have led to tables from which the positions of the sun and moon for any date in historical times, or for centuries to come, may be found. Even the eclipses recorded by the ancients have contributed to these tables, for it is evident that the tables should reproduce the eclipses as observed.

The tables used by the "Nautical Almanac" are Newcomb's "Tables of the Sun" and Brown's "Tables of the Moon." The latter is a ponderous tome, too heavy, when bound, to be accepted by the British Post Office! Its two million figures, printed at Cambridge for the Oxford University Press, are the life-work of an English-born professor living in the United States. It requires the continuous efforts of two highly skilled computers to produce from these tables the hourly ephemeris of the moon given annually in the "Nautical Almanac."

The problem of predicting the circumstances of an eclipse for a given point on a non-spherical rotating earth would at first sight seem hopelessly difficult. But the classical solution offered a century ago by Bessel, and later most ably expounded by Chauvenet, has, by the simplicity, beauty, and rigour of its conceptions, lived to this day.

The movements of the sun and moon are expressed by means of suitable rectangular co-ordinates on a fundamental plane through the centre of the earth, and at right angles to the line joining their centres. The shadow of the moon is a cone, the intersection of which with the fundamental plane is a circle. Upon this same plane the position of the observer is projected orthographically, and the projected distance from the origin, which is the centre of the earth, is resolved into components parallel to the previously chosen axes.

The co-ordinates x and y of the moon's centre, which are also the co-ordinates of the centre of the shadow, and those of the observer ξ and η, will be the same on a plane through the observer and parallel to the fundamental plane, but the radius of the shadow-cone, L, which is readily determined, will be different. The fundamental equation of eclipse prediction simply expresses the condition that when an eclipse is beginning or ending the observer is on the edge of the shadow cone, or his distance from the centre of the shadow cone is equal to its radius. Symbolically,

$$(x-\xi)^2+(y-\eta)^2=L^2.$$

The two times when this quadratic equation is satisfied represent the beginning and ending of an eclipse.

The quantities x and y, the dimensions of the shadow cone, and other functions which are independent of the position of the observer, are tabulated in the "Nautical Almanac" for each eclipse as Besselian elements. With the aid of these elements, complete predictions for any given place can be made in a few hours.

The difficulties which prevent the making of perfect predictions must now be reviewed. First, the diameters of the sun and moon. When a bright body is projected on a dark background it appears to be larger than its true size—a phenomenon known as irradiation. Hence the diameter of the moon as usually measured has to be considerably reduced for eclipse purposes; in fact, the so-called eclipse diameter, which is used in predictions, has been determined from eclipse observations alone. Further, the limb of the moon is irregular, owing to the presence of lunar mountains; on this account alone an exact prediction cannot be made, for a valley 1000 feet deep could affect the time of eclipse by a second or more, especially if the observer were near the northern or southern limit of totality.

Another difficulty lies in the unavoidable errors of the solar and lunar tables. These arise partly from the fact that some of the quantities required in their construction, such as, for example, the masses of perturbing planets, are exceedingly difficult to determine, even from a prolonged series of observations. Another contributory cause is the fact that there appear to be some unknown influences at work. Prof. E. W. Brown, formerly a pupil of the illustrious George Darwin, in the preface to his "Tables of the Moon," says: "While many efforts have been made in the past to represent the motion of the moon by gravitational theory alone, it is now admitted that this cannot be done completely. . . . There are oscillating differences which do not correspond to any theoretical gravitational terms. . . . The causes of these differences . . . are matters of conjecture.[1] . . . Still more puzzling are certain oscillations with smaller amplitudes and shorter periods. . . . All that can be done is to make an estimate . . . from the observations of the past few years whenever it is desirable to predict the position of the moon with high accuracy, as in the case of an eclipse of the sun, and alter the values obtained from the Tables accordingly."

When the coming eclipse was first accurately predicted three years ago, a correction of +7″·0 was applied to the mean longitude of the moon as derived from Brown's "Tables," but, strangely, no correction was applied to the position of the sun. The Astronomer Royal, Sir Frank Dyson, has quoted the corrections to the longitude of the sun and moon derived from recent Greenwich observations as +1″·5 and +6″·5 respectively. When these corrections replace those formerly used, the effect is very slight; it amounts to a displacement of the central line and the zone of totality as shown on the Ordnance Survey Eclipse Map, the data for which were computed from the original elements, by just one mile in a north-westerly direction.

The residual uncertainty, after the application of these corrections, should be less than half a mile in the case of the central line, and not more than a mile in the case of the northern and southern limits of totality.

The co-ordinates of the central line, and the circumstances of the eclipse along this line, are given in the table below:

G.M.T.	Longitude.	Latitude.	Sun's Altitude.	Sun's Azimuth.	Duration.
5h 23m 0s	+4° 55′·0	52° 32′·1	9·8	64·2	20·9
10	4 35·6	52 43·8	10·1	64·5	21·2
20	4 16·7	52 54·3	10·3	64·8	21·5
30	3 58·3	53 5·0	10·6	65·1	21·7
40	3 40·3	53 15·5	10·9	65·4	22·0
50	3 22·8	53 25·8	11·1	65·7	22·3
5 24 0	+3 5·7	53 35·8	11·4	66·0	22·6
10	2 48·9	53 45·7	11·6	66·3	22·9
20	2 32·5	53 55·4	11·8	66·5	23·2
30	2 16·4	54 4·9	12·1	66·8	23·5
40	2 0·6	54 14·2	12·3	67·1	23·7
50	1 45·1	54 23·4	12·5	67·3	23·9
5 25 0	+1 29·8	54 32·5	12·7	67·6	24·2
10	1 14·8	54 41·5	12·9	67·8	24·4
20	1 0·0	54 50·3	13·2	68·1	24·6
5 25 30	+0 45·5	54 59·0	13·4	68·3	24·9

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[1] Since the above was written, in 1918, several astronomers have suggested that the earth's period of revolution is variable, and have adduced evidence of a correlation between the anomalies in the motions of the Sun, Moon, Mercury, Venus, and Mars.

The Recurrence of Solar Eclipses.

By Dr. J. Jackson.

Amongst the most remarkable of discoveries made by ancient astronomers was that of the recurrence of eclipses at intervals of 18 years and 10 or 11 days. We have no knowledge of the discoverer of this period, known as the Saros, but it was certainly known to the Chaldeans. In view of the irregularities of the early calendar, such a discovery must have presented great difficulties. The fact that the interval has an odd third of a day, so that the region of visibility of an eclipse is shifted about 120° in longitude at each return, greatly increases the difficulties of discovery, and it is possible that a period three times as long as the Saros was first discovered. As the area of the earth from which an eclipse can be seen extends over a large arc in longitude, it is possible for two consecutive members of a series of eclipses to be seen from the same place. The total eclipse visible in England on Aug. 11, 1999, is indeed four Saroses later than that of June 29 of this year, but whereas this year's eclipse is in the early morning, the eclipse of Aug. 11, 1999, will be visible in England shortly before noon.

The circumstances connected with the recurrence of eclipses depend on several variables with different periods, and the apparent irregularity with which eclipses occur results from the incommensurability of the periods and differences in their relative importance. The most important period is that between successive new moons, which on the average is 29·5306 days. An eclipse of the sun would take place at every new moon if the orbital planes of the sun and moon coincided,[1] but as the inclination of the two planes is considerable—varying round 5°—it is only when new moon occurs near the line of intersection of the two planes, known as the line of nodes, that an eclipse can take place. On account of the motion of the plane of the moon's motion, the sun passes through the nodes at intervals of less than six months, the average time being 173·310 days, and this is the second important period in connexion with eclipses. Eclipses take place at intervals which are very nearly multiples of 29·5306 days and are approximately multiples of 173·310 days.

The maximum angular distance which the sun can be from the node at the time of an eclipse (known as the eclipse limit) depends on the distances of the sun and moon from the earth and the actual inclination of the orbital planes. It varies from 15¼° to 18½°. As the sun moves on the average almost exactly 2 × 15¼° relative to the nodes between successive new moons, and as it is moving most slowly when the eclipse limits are smallest, an eclipse occurs near every passage of the sun through a node. There are thus at least two solar eclipses every year, and there may be as many as five, the latter only occurring when the sun passes through a node near the beginning or end of the calendar year. Eclipses of the moon may take place at the full moons preceding and following eclipses of the sun, although for them the eclipse limits are smaller.

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[1] If this were the case, however, all central eclipses would take place within the tropics, and the only eclipses that could be seen from England would be extremely small partial eclipses at the new moons near midsummer.

The Saros is connected with the two periods we have just mentioned. We have in fact

$$223 \times 29{\cdot}5306 \text{ days} = 6585{\cdot}32 \text{ days.}$$
$$38 \times 173{\cdot}310 \quad ,, \quad = 6585{\cdot}78 \quad ,,$$

The Saros is 6585·32 days. As the sun travels on the average about 1° a day, it describes in a Saros only about 28′ less than 19 revolutions relative to the nodes. As 28′ is a small fraction of the eclipse limits, we find a large number of eclipses recurring in a series.

The number of eclipses in a series varies one or two either way from seventy and extends over a period of 1200 years. Of these, about twelve or thirteen at each end are only partial eclipses, as the sun is so far from the node that the line going through the centres of the sun and moon passes clear of the earth. For the middle, forty-five or so, this line comes to earth, giving rise to a central eclipse which is total or annular according as the angular diameter of the moon or sun is the larger.

The eccentricity of the apparent orbit of the sun is small, so that the angular semi-diameter of the sun varies only from 15′ 46″ to 16′ 18″. Also we have seen the Saros differs from an exact number of years by about 11 days, so that at the recurrence of an eclipse the apparent diameter of the sun cannot have altered more than 3″. The eccentricity of the lunar orbit is larger, causing the apparent semi-diameter of the moon to vary from 14′ 42″ to 16′ 46″. On account of the rather rapid motion of the moon's apse, amounting to a whole revolution in about nine years, the interval between successive nearest approaches of the moon to the earth is on the average 27·55455 days and

$$239 \times 27{\cdot}55455 \text{ days} = 6585{\cdot}54 \text{ days.}$$

This differs from the Saros by only 0·22 of a day. This is a remarkable and important coincidence. It means that after a Saros the mean anomaly of the moon has altered by only about 2°·8 (decrease), and the apparent diameter of the moon, like the sun, has not altered by more than 3″. The con-

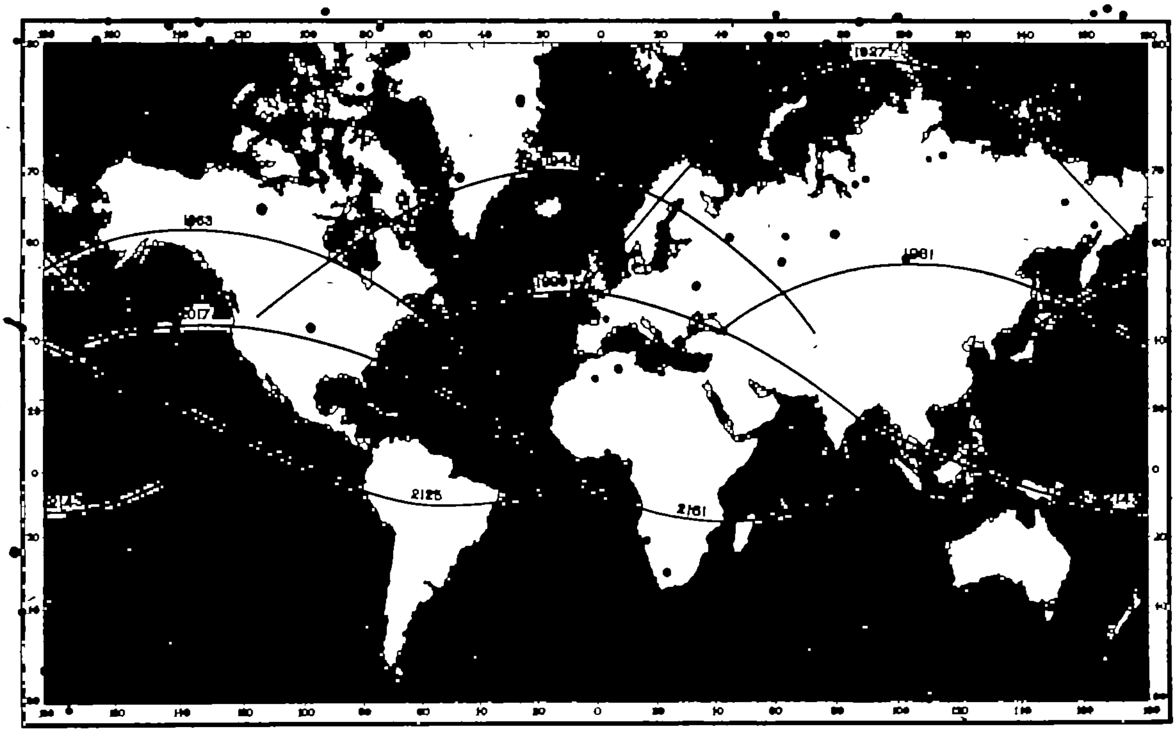

Fig. 1.—Successive tracks of solar eclipses.

sequence of all this is that the duration of totality in a series of eclipses varies slowly from one eclipse to the next, and that we have a series of total eclipses, or of annular eclipses. If the period of rotation of the lunar apse were twelve years instead of nine years, annular and total eclipses would alternate. It might be noted here that as a result of the moon returning to approximately the same distance from the earth after a Saros, its parallax is only slightly altered, and so the eclipse limits only slightly altered.

Let us now consider the series of eclipses to which that of June 29 of this year belongs. At the new moon of May 26, 1873, the central line from the sun to the moon passed just north of the earth and there was a large partial eclipse near the north pole. If we work backwards from this date at intervals of 18 years and 10 or 11 days, we find a series of decreasing partial eclipses near the north pole. Going forwards, we find that on June 6, 1891, the central line passed over the north pole but came to earth in northern Asia, producing an eclipse at midnight. This was an annular eclipse very nearly total, and was the first central eclipse of the series to which the eclipse of this year belongs. Eighteen years later, on June 17, 1909, there was an eclipse which crossed the earth near the pole. This eclipse was just total, although it was scarcely certain beforehand that it would be so. We then come to the total eclipse of this year. Proceeding onwards, we get a series of eclipses gradually lengthening in duration and working equatorwards, while the longitude on the earth where the eclipse takes place moves about 120° westward from each eclipse to the next.

The "Nautical Almanac" gave the semi-diameters of the sun and moon as seen from the centre of the earth for the eclipses of 1891, 1909, and 1927 as follows:

	Moon.	Sun.
1891 June 6 . .	15′ 42″·2	15′ 47″·5
1909 June 17 . .	43″·1	44″·3
1927 June 29 . .	46″·7	44″·0

These figures indicate the way in which the apparent diameter of the moon is gradually increasing relative to that of the sun. Also on the eclipse track the apparent diameter of the moon must be larger than from the earth's centre, so that the total eclipses of this series will be steadily lengthening.

The following table indicates the change of position of the point on the earth where central eclipse occurs at noon, for a few eclipses belonging to the series of the eclipse of this year. The longitudes are measured towards the east. It will be seen that the track moves about 8° southward each year and a little more than 100° in longitude. After two hundred years, when the track is near the equator, the movement is about 5° southward and 120° westward each year.

	Longitude E.	Latitude.
1909 June 17 . .	187°	+88°
1927 June 29 . .	84	+78
1945 July 9 . .	340	+70
1963 July 20 . .	234	+62
1981 July 31 . .	127	+54
1999 Aug. 11 . .	18	+46
....	......	......
2107 Oct. 16 . .	39	+ 2
2125 Oct. 26 . .	276	− 4
2145 Nov. 7 . .	150	− 9
2161 Nov. 17 . .	23	−14

The map (Fig. 1) shows the track of the approximate central line for the eclipses of 1927, 1945, 1963, 1981, 1999, 2017, and 2125, 2143, 2161. In each case the eclipse begins at the western end of its track at sunrise and finishes at the eastern end at sunset.

Future Total Solar Eclipses in the British Isles.

By Dr. A. C. D. CROMMELIN.

AN article by Dr. W. J. S. Lockyer in NATURE for Jan. 15 last described and illustrated the total solar eclipses in the British Isles from A.D. 878 to A.D. 1999. The present article continues this investigation for another thousand years. In view of the very long interval of two centuries that has elapsed since there has been a British totality, it is interesting to determine the average interval between these events. Mr. J. Maguire's list, used by Dr. Lockyer, has a few omissions. I therefore had recourse to the maps in Oppolzer's Canon of Eclipses. These indicate 63 British totalities in 3370 years (1208 B.C. to A.D. 2161), or 19 in a thousand years, giving an average interval of 54 years between totalities. I am aware that the maps in the Canon show the tracks as circular arcs not quite agreeing with the true ones, but for statistical purposes this is of no importance; we clearly gain as many as we lose by the distortion.

As a check I find that Otto Schrader gives 21 eclipses as total in the British Isles in the period A.D. 2133 to A.D. 3045. Four of these are doubtful; the central line lying outside these islands: giving these half weight, we have 19 in 900 years, or 21 in a thousand years. So we are safe in concluding that the average number in a thousand years is 19 or 20, giving an average interval of 53 years. I have here included the Shetlands in the British Isles. If we exclude them (they were not included in Dr. Lockyer's map, reproduced in Fig. 1) we may take the average interval as about 58 years.

If instead of a large area we consider a point on the earth's surface, we have on the average 3 total eclipses, 4 annular ones, and nearly 400 partial ones visible there in 1000 years. But we should have to take several thousands of years to make the average numbers for totality and annularity correct. In shorter periods we find some striking anomalies; thus a small region in Scotland round the point 3° 40′ W., 55° 30′ N., will have three totalities all under favourable conditions within 61 years (A.D. 2381, 2426, and 2442). Also, the grouping of totalities in the British Isles as a whole is much less regular than we might expect as a result of three such uniform motions as the rotation and revolution of the earth and the revolution of the moon. They bunch at one epoch and spread out at another in a manner that recalls the service of tram-cars. The blank period of 203 years that is now ending is the longest between A.D. 800 and A.D. 3100. The gap between A.D. 2200 and A.D. 2381 comes second, and that between A.D. 1433 and A.D. 1598 third.

On the other hand, the most striking example of bunching is between A.D. 2081 and A.D. 2200; we have here seven certain totalities and two others that are likely to reach the shores of Great Britain within 119 years.

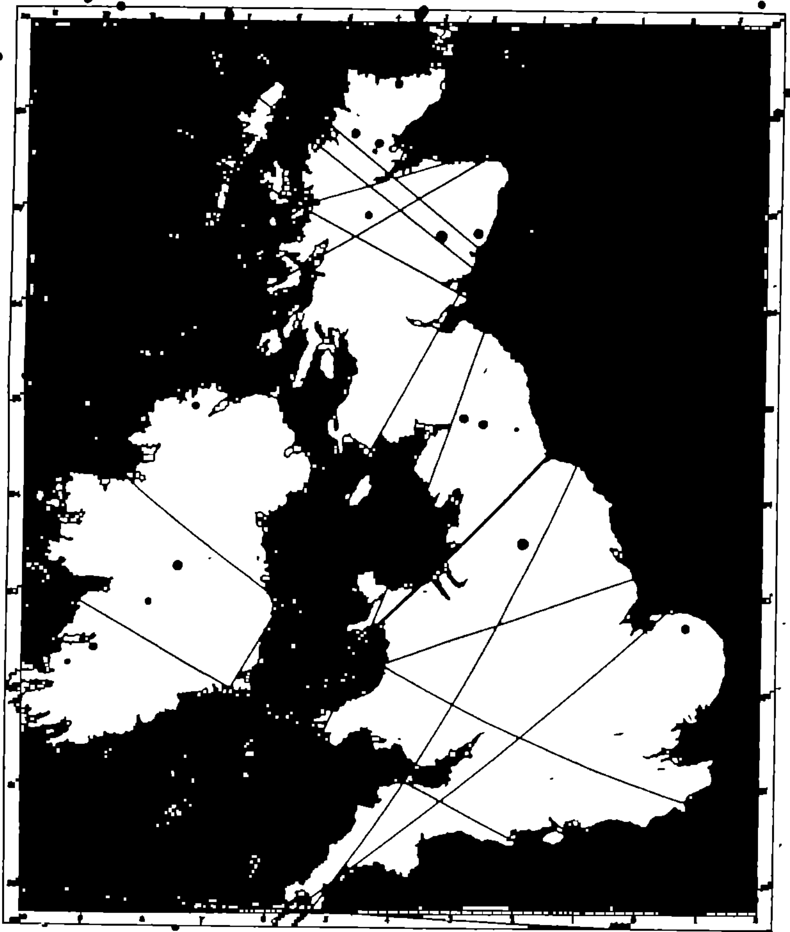

FIG. 1.

The following are the data from which the tracks in the accompanying map (Fig. 2) were laid down:

(1) For the period A.D. 2000 to A.D. 2161 they are from my own calculations, using the elements in Oppolzer's Canon.

(2) For A.D. 2189 from my own calculations, using Hansen's tables of the moon and Newcomb's of the sun. This eclipse was inadvertently omitted by Schrader.

(3) From A.D. 2200 to the end from Otto Schrader, "Die bedeutenden Sonnenfinsternisse und die grossen Mondfinsternisse für Mittel-Europa" (P. Stankiewicz, Berlin, 1913).

It is to be remembered that the lunar tables used by Oppolzer omit many small terms; consequently the eclipse tracks calculated from them are uncertain by about 25 miles at the present time; and since the accelerations used in them differ considerably from those now accepted, the uncertainty becomes markedly greater after an interval of several centuries either in the past or the future. I understand that the tables used by Schrader are simply an extension of Oppolzer's, so they are subject to similar uncertainty, and tracks several centuries ahead can only be taken as approximate.

A few notes follow on some of the eclipses the central lines of which are shown on the map. The eclipse of A.D. 2081 is a return after seven Saroses of the Philippine Islands' eclipse of 1955, which has the remarkable duration of totality of 7m 6s. If Oppolzer's data are accurate totality should reach the Lizard. Although the central line in A.D. 2090 is some distance from the shores of the British Isles, the track is so wide through foreshortening that the shadow will reach the south-west coast. In A.D. 2142, totality may reach Dungeness. In A.D. 2151, Oppolzer's elements would give totality in London, but those of Hind, Maguire, and Johnson do not; their tracks are farther north. The eclipses of A.D. 2381, 2681, and 2726 are remarkable for long totalities. The latter seems to be a record for Europe, reaching 6 minutes. The Lizard will probably be within the shadow; the Channel Islands certainly will.

The following table gives the dates of all total eclipses that may reach the shores of the British Isles, the approximate hour, the sun's altitude and the duration on the central line. I have diminished the durations given by Oppolzer's and Schrader's elements by 0·2^m, since they use too large a diameter for the moon.

Date.	Hour.	Sun's alt.	Dur.
2081 Sept. 3	7 A.M.	18°	3·5^m
2090 Sept. 23	5 P.M.	6	2·8
2133 June 3	9 A.M.	40	3·5
2135 Oct. 7	8 A.M.	7	2·7
2142 May 25	9 A.M.	43	2·9
2151 June 14	6 P.M.	15	2·6
2160 June 4	6 P.M.	22	2·1
2189 Nov. 8	8 A.M.	8	2·5
2200 April 14	5 P.M.	17	0·4
2381 July 22	10 A.M.	48	5·0
2426 Sept. 2	8 A.M.	25	3·9
2442 April 11	9 A.M.	33	1·7
2545 April 12	5 P.M.	15	0·2
2600 May 5	6 A.M.	12	2·7
2681 June 8	2 P.M.	50	4·5
2726 July 21	11 A.M.	58	5·7
2808 Aug. 13	6 A.M.	8	0·3
2817 Sept. 2	4 P.M.	21	0·9
2864 Feb. 28	1 P.M.	29	2·8
2911 Aug. 15	2 P.M.	37	3·0
2927 Mar. 24	2 P.M.	31	3·0
2972 May 4	3 P.M.	37	3·8
2974 Sept. 7	1 P.M.	35	4·1

The central lines of 2081, 2090, 2726 pass respectively 70, 140, and 93 miles south of the Lizard; that of 2974 passes 44 miles north-east of Unst (Shetlands).

In the above list the eclipses of A.D. 2081, 2135, and 2189 illustrate the triple Saros; those of A.D. 2133, 2151, and 2142, 2160 the simple Saros; those of A.D. 2864, 2972 the sixfold Saros: the intermediate eclipse in 2918 passes north of the Shetlands. Those of A.D. 2081, 2381, and 2681, also A.D. 2142, 2442, also A.D. 2426, 2726, illustrate the 300-year cycle: those of A.D. 2160, 2681 illustrate the 521-year cycle.

Taking the present list and Dr. Lockyer's together, there are two examples of a 2-year interval between British totalities: A.D. 2133, 2135, and A.D. 2972, 2974; three of a 7-year interval: A.D. 878, 885, and A.D. 1133, 1140, and A.D. 2135, 2142; six of a 9-year interval: A.D. 1424, 1433, and A.D. 1715, 1724, and A.D. 2081, 2090, and A.D. 2133, 2142, and A.D. 2151, 2160, and A.D. 2808, 2817.

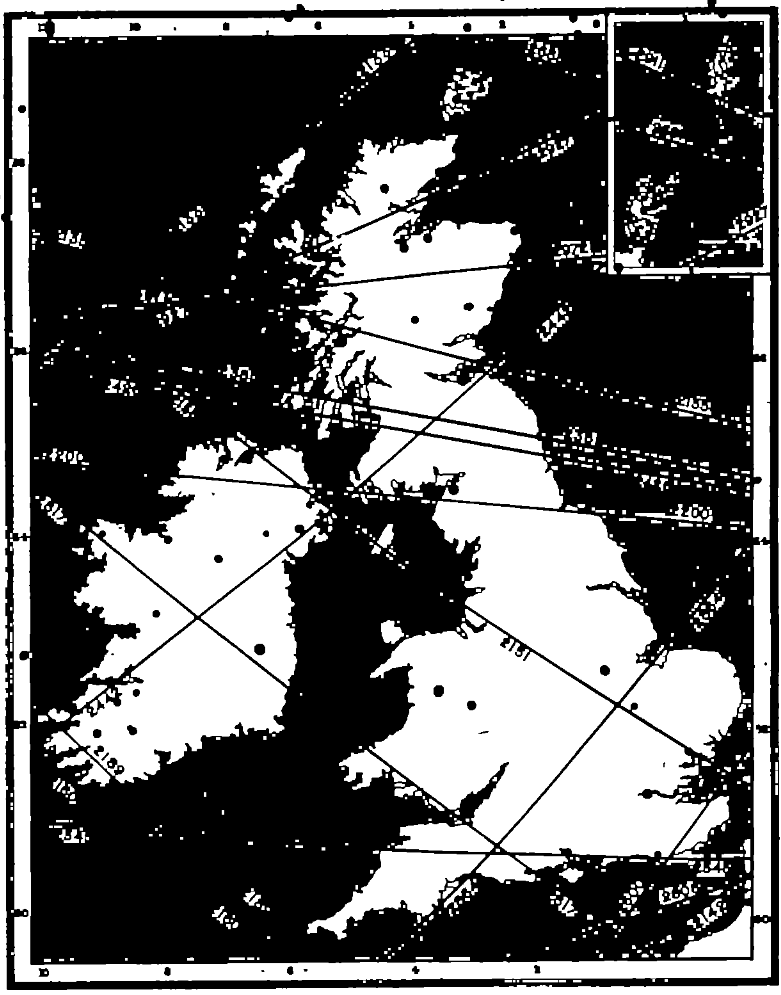

FIG. 2.

Meteorological Conditions in Relation to Eclipse Observations.

By R. CORLESS.

THE eclipse of the sun which will occur at about 5 h. 23 m. G.M.T. (6.23 A.M. summer time) on June 29 will appear total to observers stationed upon a strip of country 28 or 29 miles wide, of which the central line stretches from Criccieth in North Wales to Hartlepool in Durham. The character of the country included in this strip is very varied. There are coastal areas on the Lleyn Peninsula and North Wales, in Lancashire and between Sunderland and Salt-burn on the east coast; there are, on the other hand, the mountain peaks of Snowdon, Whernside, Penyghent, and many others; and there is a considerable gradation of hill, plateau, valley, and plain between these extremes.

It is worth consideration whether the climatological records suffice to indicate which type of country in the belt is likely to provide the most favourable weather conditions for viewing the eclipse. The question resolves itself into the identification of the places which, on the average, are most free from cloud, mist, and fog. The records do not furnish a direct answer to this question, because observations of cloud are not sufficiently numerous and well distributed along the belt to define with precision the average distribution of cloudiness. A consideration of other records, notably of rainfall, sunshine, and visibility, indicates, however, that the conditions which produce bad seeing are so different in character on different occasions, that it is better not to deal with averages, but to classify the various occasions into types, and to consider the physical conditions associated with different types.

A broad classification can be made into the following occasions:

(1) When seeing is bad everywhere.
(2) When it is variable.
(3) When it is bad on the hills and good elsewhere.
(4) When it is bad in the low-lying valleys and good elsewhere.
(5) When it is good everywhere.

(1) Occasions when seeing is bad everywhere are most likely to occur when a widespread canopy of cloud is produced in a depression or region of relatively low barometric pressure. But they also occur in certain anticyclones where an inversion of temperature at a moderate height prevents vertical motion of air, and so favours the development of a layer of cloud just below the inversion. In the latter case the summits of mountains may be places from which a good view can be obtained.

(2) The condition in which seeing is variable and changeable is characteristic of a depression of less intensity than that of the previous case. Especially in the rear of the disturbance the weather may be showery, and bands of cloud may alternate with stretches of relatively clear sky.

(3) The third case, in which seeing is bad on the hills and good elsewhere, is in general due to the formation of persistent cloud on and above the hills as a result of the lowering of temperature in a current of rather moist air, which is forced upwards by the obstacle of the hills themselves. The clouds disappear on the lee side of the hills because the temperature of the air-current increases again in its descent after surmounting the crest. In this case a definite air-current is an essential part of the process, and as wind is detrimental to fog formation, mist and fog are not normally found at low levels.

(4) In this case seeing is bad in the low-lying valleys, in consequence of the development of mist or fog, but good elsewhere. This condition is characteristic of the early morning in anticyclonic, cloudless summer weather. It arises from the cooling of the ground by radiation to the clear sky during the previous night, which leads to the cooling of the surface layers of air by conduction. Conditions being anticyclonic, there is usually little or no wind, consequently the cold surface air flows into the valleys by gravitation. The temperature of this air continues to fall as the night progresses, until by daylight it is probably below the dew-point, and the cold air is coterminous with a sea of fog with a flat, well-marked top, which is fatal to good seeing for observers enveloped in it. Above the fog the air is clear and cloud is usually absent.

(5) The fifth case provides the most favourable conditions for good visibility everywhere. It differs from the last in that fog is not formed in the valleys because air movement in the anticyclone is sufficient to overcome the tendency of the chilled surface layers to gravitate into the valleys. Mixing of the lower layers by turbulence takes place and prevents the temperature from falling to the dew-point. Meteorologically the two cases are not readily distinguished, but the results are very different to observers stationed in deep valleys.

In the absence of information as to the probable distribution of barometric pressure on the morning of the eclipse, the only practical conclusion that can be drawn is that it is advisable to avoid both high ground and very low ground. But on the day prior to the eclipse it should be possible, with the aid of the current weather map, to form an opinion as to which of the five general conditions of weather described above is likely to be experienced on the following morning.

Naked-Eye Observations of an Eclipse of the Sun.

By Annie S. D. Maunder.

No observer of the partial phase of a total solar eclipse should look at the sun with the naked eye. During this phase some people advise the use of coloured gelatine spectacles, smoked glass, or darkened photographic film; others advocate a graduated screen, using always the densest possible part of it. A very serious attitude is taken in the *Lancet* of April 30, where two ophthalmic surgeons urge that the public must be made to understand that neither smoked glass nor fogged photographic film are safe screens even when well prepared, seeing that they do not absorb the irritant ultra-violet rays, and to avoid the risk of 'eclipse blindness' use must be made of a photographic film which (after fogging so as to obtain the necessary density) has been treated by a special process which excludes wave-lengths shorter than 4000 Å.U.

My own precautionary method is at once safer, cheaper, and more effective. It is this: Do not look at the sun at all—either with the eyes screened or unscreened—until totality is just about to begin. During the partial phase there is nothing on the sun of interest that cannot be seen better by looking on the earth. In other words, project in all cases the sun's image on a screen—white card, ground glass, pavement, or wall—whether the projection be through a telescope, or the 'pinholes' made in a cardboard, or between the leaves of a tree. (Projection, on ground glass or white cardboard, through a telescope, is of course the best way for timing the four contacts of sun and moon.) The little 'decrescent' or 'crescent' suns upon a wall or pavement are very pretty to watch and can easily be photographed. Nor is it the image only of the sun itself that becomes bow-shaped, but also the shadows cast by it. I first noticed this in the very large partial eclipse of 1912, seen in Paris, as an eclipse something between total and annular, when the sun was high in the heavens at noon, and standing on the flat roof of a house in Greenwich, I looked down on my shadow far below on the pavement. This showed my ears pointed like the traditional faun's; and, more curious still, when I stretched out my open hand, all my finger-tips were drawn out and bent like a bird's claw.

By the time that the sun has become a narrow bow in outline, and there remain but a few minutes, perhaps three or four, before the actual beginning of totality, the shadow-bands should begin to dance in streaks or wavy lines. I have heard these compared to many things, but I have never had the good fortune to see them myself; to the shadows of the ripples on the surface of the clear water dancing on the shingly beach below; to the shadows cast on the wall of a room from rippling sunlit waters outside. In the words of Mr. C. L. Brook (at the 1900 eclipse), "ripples raised on water by a bright breeze represent best what may be termed the structure of the shadows; they all move in the same direction, each ripple element is linear in character but retains its individuality only for a moment, appears to dissolve away and others take its place." In the Australian eclipse of 1922, some observers saw a flickering shadow hovering *over* distant trees eleven minutes before totality; later, on the ground, round their feet: "they flitted under the trees as the shadow of a bird might when flying above." Immediately after totality, the whole light was crimson for about ten seconds, and *red* and *black* shadow-bands raced over the ground. The bands were seen by chromospheric, not by sunlight. From the scientific point of view, the ideal occasion for their observation was in the American eclipse of January 1925, when Nature itself provided a white carpet for them to dance upon. It has been thought that they were due to currents in our upper atmosphere and that we could learn from them something about this; but the Americans observed them too closely and found that they were wind swirls—little 'devils' they are called in India—close to the ground, and in one place were seen to be chasing one another in all directions round a tree.

Whether the onrush of the moon's shadow can be seen at the coming eclipse will depend on whether the weather is clear or hazy. At the American eclipse it was looked for, but was undefined because of the haze. Major Hepburn says that this is the most impressive feature of the spectacle: "the onrush from a certain direction of rapidly spreading and engulfing darkness." But those who have work to do during totality have to forgo this experience.

The eclipse of June 29 is a young one; it is total—and not very much total at that—for the first time; when it is a Saros older it will be better. As a consequence, the chromospheric ring will probably be visible throughout the whole period that the sun's disc is covered. The form and size of the corona will depend on the actual state of activity of the sun at the moment. If there are many and great sunspots and prominences, and if these are near the sun's edge, then we may expect a complex inner corona, which, however, will only show to the naked eye as a bright silver ring surrounding the narrow pink circlet of the chromosphere, with long coronal streamers extending in all directions; if there are no spots and insignificant prominences on the sun, then the coronal wings will lie folded along the sun's equator. Prominences, of course, will be visible to the naked eye only if large enough; keen sight could detect a prominence of 40,000 miles height; one of 200,000 miles should be easily visible. The corona will be ivory or white in colour; the chromosphere will be rosy; prominences will probably be red, but they may be white.

We would wish for June 29, that the weather on the sun should be stormy with many eruptions; that—for naked-eye observers—there should be deep lunar valleys near the points of second and third contacts; and that great red prominences should show up where these lunar valleys are.

In the American eclipse of 1925, New York City had a very beautiful aspect of the eclipse, which there was of short totality. The eclipsed sun showed as a faint circle of light with an intensely brilliant place at one spot, the rays from which spread out and gave the impression of a ring with a big diamond inserted in the usual way. There was a depression in the moon's edge which grazed the edge of the sun for some time, as seen from New York, which lay on the edge of the shadow track, just as Liverpool lies (probably) on the edge of the shadow track on June 29 next. In one of the Russian chronicles there is a description of the eclipse of May 1, 1185: “In the evening there was an eclipse of the sun. It was getting very gloomy and stars were seen, and in the men's eyes was a green light. The sun became similar in appearance to the moon, and from its horns came out somewhat like live embers”; which seems to point to something like the ‘diamond ring,’ perhaps a prominence as well as sunlight.

I have myself only once seen the eclipsed sun with the naked eye, and then it seemed small, much smaller than the full sun and moon to which I have been accustomed. But this was in India, with the sun high in the heavens. Mr. H. B. Adames saw the beginning of the eclipse of 1905 as the sun rose over Lake Winnipeg, and to him the entire body of the moon, which suddenly appeared with a blood-red prominence on either side, was a “huge black ball immensely exaggerated.”

The effect of the rapidly diminishing sunlight on land and sky is weird and uncanny; all life and warmth fade out of the landscape; the flowers look withered, the grass and trees lose all trace of their living green and become of a dull lead colour; even the very faces of the observers become livid. If the sky is blue, it changes to a deep funereal purple. If there are small clouds near the sun, the iridescent colours, which are always there but not always easily seen, stand out vividly as in a spectrum. Round the horizon—which is near or beyond the shadow's edge—there is a glow of an angry gold, a sulphur light, not untinged with red. These are sunset effects, perhaps, which become visible when the daylight is cut off, but they may owe something also, as Mr. C. T. Whitmell suggested, to the red chromospheric light. If clear, it will be well to glance at the shadows cast by the corona; in 1922, Miss Miriam Chisholm found that these, though present, were undefined.

In my opinion, all naked-eye observers who are artists should make the painting of the colour effects on land, sky, and sea their chief study at this eclipse. It is not, of course, possible to do this work actually in the short totality, but the outline should be drawn before the eclipse, the colours noted during the total phase, and the painting finished afterwards while the tints are still fresh in the memory. Like meteorologists, artists get their results, whether the eclipse is clear or cloudy.

Eclipse Photography.

By C. P. Butler.

ALTHOUGH the total solar eclipse on Wednesday, June 29, will be one of short duration—about 23 seconds total obscuration in England, and 30 to 40 seconds in Norway—the improvements in sensitivity of photographic materials and design of optical equipment warrant the attempt to obtain photographic records of various stages of the phenomenon. In order to give information wanted by observers having diversity of equipment, we may briefly summarise the various means with which observations may usefully be undertaken.

Ordinary Cameras.—These may range from the modest hand-camera to the largest field or studio apparatus, preferably fitted with some controllable exposing apparatus other than merely the lens cap. These may all give interesting pictures, but the scale of the result will be strictly proportional to the focal length of the lens employed. The diameters of the sun and moon are about half a degree of arc on the sky, so it is a simple matter to calculate what the actual linear diameter of the image of the eclipsed sun will be with any given lens; an ordinary camera of, say, 7 inches focus, will give an image about $\frac{1}{16}$ inch diameter; one of 12 inches focus an image about $\frac{1}{10}$ inch diameter. In spite of the small scale, such lenses in previous years have given very beautifully defined pictures of the eclipsed sun and the surrounding corona. For the delicate outer streamers of the corona such apparatus is very efficient, and, possibly more suitable than the larger scale instruments. This was illustrated by the success of Mrs. Maunder at the eclipse of 1898 in India, when the photographed coronal streamers extended about eight solar diameters from the edge of the moon. In this work of photographing an illuminated *area*, the power of the lens is regulated by the ordinary *f* value, *i.e.* the ratio of aperture to focal length, so that lenses with the largest *a/f* value available should be chosen for this occasion.

Telephoto Cameras.—By means of an auxiliary lens, generally concave, to reduce the bulk of the apparatus, increased focal lengths may be obtained with a given camera. Photographers having telephoto attachments to their lenses will be able to obtain large-scale pictures, but if the equivalent focal length is more than about 20 inches, some method of moving the camera with the sun will be necessary for exposures longer than a few seconds.

Long-focus Lenses or Telescopes.—These instruments are usually of larger aperture than a telephoto lens of similar focal length would be, so that, even when stationary, a useful picture may be possible with a snap-shot or short-time exposure. If furnished with clock-work drive, they provide perhaps the most important means of obtaining details of the structure of the eclipsed sun. Good results may be obtained by adjusting an ordinary camera, with lens set for infinity, immediately behind the eyepiece of a visual telescope which has also been adjusted on the distant object. If this arrangement is selected, it would be best mounted on a long, stiff board, and the whole fixed on a firm support pointing to the sun. The exposure should be made by rubber tube or antinous release, to avoid vibration.

Stationary or Clock-driven Apparatus.—With such a short eclipse it is doubtful if anything will be gained by installing temporary driving apparatus to follow the movement of the sun. Unless the utmost rigidity is secured, the small errors in fixing, driving, etc., may be greater than the actual movement of the object. The best advice appears to be that the camera should be firmly fixed on some rigid support, provided with a wedge adjusted to the elevation of the sun (about 11° in England). With instruments of moderate focal length the movement during the possible exposures will be scarcely perceptible. The movement may begin to be effective when focal lengths of more than 20 inches are employed.

Alteration of Eclipse Track.—Notice should be taken of the recent alteration of the track of the eclipse and its time of occurrence. The latest calculations, kindly furnished by Dr. Comrie, of the "Nautical Almanac" Office (*Monthly Notices, Royal Astronomical Society*, vol. 87, April, p. 496), place the central line about *one mile farther north* than the previously published track, so that observers located near the southern limit as shown on the Ordnance Survey Map should move to some station at least two or three miles northwards, to be certain of complete obscuration. Observers near the northern limit of totality will be better situated in consequence of the alteration. The time of occurrence is only about 4 seconds later than the published time.

Perhaps a word here as to the actual method of observing the instants of totality will be welcome to those who have not previously seen a total eclipse of the sun. The moon commences to enter on the sun's north-western edge, about the position of 2-hours on a clock face as one faces the sun, and will gradually cross the disc in a slanting direction, roughly towards the 8-hour position. When near totality, about an hour after first contact, the sun will be 25° north of the east point of the horizon and at an elevation of about 11° above the horizon, these figures being slightly different at various localities. As the advancing edge of the moon gradually approaches the eastern edge of the sun, the intense white arc of sunlight will be broken into small beads, produced by the rough mountainous edge of the moon. The instant when the last of these bright spots disappears is the time of second contact, and denotes the beginning of totality. Unless the observer wishes to obtain a series of records, the exposure should not begin until this instant of second contact, otherwise the delicate features of chromosphere and corona will be lost in the bright glare.

It is advisable to protect the eyes with dark glasses, such as may be made from a densely fogged photographic plate, or ordinary deep-tinted neutral glass, until totality occurs. From second contact to third contact is the period of totality, which in England is expected to last for about 23 seconds. This is the time available for securing pictures of the corona, which can never be seen except in these special circumstances, and the exposures to be given will depend on the number of pictures to be taken. In general it would be advisable to limit the number to three :

(i.) A snap-shot just after the last beads of sunlight are seen to disappear at the moon's eastern or advancing edge. This will give the prominences and perhaps the inner corona.

(ii.) A longer exposure of, say, 15 to 20 seconds, depending on the time occupied in changing plates.

(iii.) Another snap-shot just as the bright beads appear at the western edge of the black moon.

Cinema Record.—The eclipse, being of short duration, may be specially suitable for the taking of a cinematograph film of the various stages, in which case the exposures would be started some time before totality, to show the transition from partial to total phase.

Intending observers who are able to go farther afield will find the photographic conditions somewhat more promising in Norway, where the altitude of the sun during totality will be about 21°.

Photographic Plates.—In general it will be best for the photographer to use the plates to which he is accustomed. All the well-known brands of material, glass plates and films, are now so uniformly good with regard to clean working that any choice may be governed by whatever special features it is desired to obtain. If only one exposure is to be attempted, the most rapid emulsion is to be recommended. All the chief makers list plates from 350 to 650 H and D. For the corona much of the light is concentrated in a few special colours, violet, blue, green and red, the combination giving the silvery white sheen characteristic of the solar envelope. Ordinary plates, of whatever speed, will record only the violet and blue portions. To get the advantage of the visible colour action, panchromatic plates may be used. The outstanding plates of this variety are the Ilford Iso Zenith, Iso Wellington, and Imperial Eclipse Ortho, all being of the highest sensitivity and very clean working. Most makers also supply Spectrum Panchromatic Plates, which are of somewhat lower speed, but give a more equable representation of the spectrum colours. When the apparatus is fitted with lenses of large relative aperture, these plates may be used instead of those of greatest rapidity. The easiest way of treating these colour-sensitive plates is to develop in darkness for six minutes with the metol-hydroquinone solution recommended by the makers. For those, however, who cannot resist the temptation to enjoy seeing the image gradually built up, use may be made of one of the various desensitising solutions which are now available. Before development, and in darkness, bathe the exposed plate in a weak solution of the desensitiser, such as phenosafranine, for about one minute. Then add the developer, and continue for a further six minutes, during which an ordinary safelight may be used to see the progress of development.

There is one possibility of difficulty, owing to the early hour (6 h. 23 m. A.M. British summer time) at which the eclipse will take place. If the sky is slightly hazy, the contrast of the silvery-white coronal structure may be lessened with respect to the sky background. With ordinary plates this cannot easily be remedied. But if panchromatic plates are employed, much of the sky glare may be eliminated by using a moderately tinted colour screen, of the type known as K_3, which will cut out much of the blue glare, and yet pass sufficient of the green, yellow, and red to the panchromatic plate to give good density in the image.

Supersensitised Plates.—For observers with more experience, most varieties of plates may be hypersensitised by a preliminary ammonia bath. The plates are simply bathed in a weak solution of ammonium hydrate (about 1 per cent.) for one minute, at a temperature of about 50° F. (14·5° C.). Then dry the plate as quickly as possible, either by a centrifuge or a fan. All this should be done in darkness. If an alcoholic solution is preferred, the plate will dry much quicker, but the resulting sensitivity will be slightly lessened.

Films.—Observers desiring to use films may do so with every confidence; and as many film emulsions are now made colour-sensitive, the remarks already made as to using colour screens, if glare is present, also apply to films.

Colour Photography.—Many observers intimate their intention to try for colour records of the eclipse phenomena, for which several processes are available.

Backing.—It is advisable that all plates should be backed, as any traces of halation due to bright portions of corona, prominences, or slight cloud may otherwise diminish the delicacy of detail.

Shadow Bands.—In addition to the corona and prominences, there are several other features peculiar to a total solar eclipse which may be of interest to photographers wishful of a more extensive programme. Just before totality, and immediately after, a series of moving wavy shadows are usually seen on the ground or sides of buildings facing the eclipsed sun. The cause of these is not yet known with certainty, but they appear to have some relation to prevailing atmospheric conditions. If a white sheet or a whitewashed wall can be used, photographs of these shadow-bands will be of value. Exact details of the position of the flat surface, whether horizontal or vertical, its direction with regard to north, south, etc., should be carefully noted. Also the actual width, rate of motion, and general direction of the bands on the white surface, and which way they move.

The Moon's Shadow.—This applies chiefly to observers who may be fortunate in occupying a hill station in Wales, Lancashire, or Yorkshire. The dense black shadow may be seen travelling over the landscape, and would form an interesting photographic study wherever possible. Only snap-shots may be made on this, owing to the great velocity of the moon's shadow over the earth's surface.

Landscape Colours.—Very varied descriptions of the remarkable changes of colour of landscape features have been noted during previous eclipses. Those provided with panchromatic plates or colour plates may do useful work in recording any of these changes. In such cases photographs of the same landscape under ordinary daylight conditions should be obtained to indicate changes due to the eclipse.

Spectroscopic Photographs.—So far we have only considered the photography of the eclipsed sun as a picture. There must be many observers who could photograph the spectrum of the phenomenon, and quite valuable records may be made with simple equipment. Either a prism or diffraction grating may be used, adjusted in front of the camera lens. In general this will involve some deviation of the pointing of the camera, which will have to be directed away from the line of the sun by an angle equal to the deviation produced by the prism, etc. Prisms and gratings can, however, be obtained which are arranged to give direct vision, and in such cases the procedure is exactly the same as with the camera lens alone. Very good results can be obtained with the replica gratings produced by the Thorp process, an additional feature being their relatively small cost compared with that of an original ruling on speculum metal. The photographic manipulation is identical with that for ordinary pictures, except that it is scarcely worth using any except panchromatic plates, which will record the whole of the visible spectrum.

Time Records of Exposure.—The scientific value of any records obtained will be greatly enhanced if the instants of exposure are noted as accurately as possible. The track of the eclipse passes through such populated areas that few observers will be far away from some place where it should be possible to get facilities for listening to the standard time signals which will be broadcast from Greenwich and Paris. The well-known Greenwich six dots, the sixth indicating the time to be noted, will be broadcast at 6 h., 6 h. 15 m. and 6 h. 30 m. A.M. British summer time on June 29. (The latest arrangements for the broadcast time-signals will be found in "Our Astronomical Column.") Perhaps it would be a general convenience if the present 1.0 P.M. signals from Big Ben (12.0 G.M. noon) were given as Greenwich dots for the week preceding the eclipse. The Paris Observatory is also broadcasting from the Eiffel Tower (FL) rhythmic and other time signals specially for the eclipse on both spark and continuous wave.

Any records which can be made to the nearest second will be comparable in accuracy with the determinations of actual beginning and ending of the eclipse itself.

To summarise briefly:

(1) Arrange for a steady support for the camera directed to the sun, special care being taken if there should be a high wind.

(2) Provide the camera with a lens of as large a relative aperture as possible.

(3) Use rapid plates, preferably panchromatic, with a light-yellow screen, and have the plates backed.

(4) Exposures should be from snap-shot to about 10, 15, or 20 seconds for cameras up to 20 inches focal length. For longer cameras it is better to confine exposures to about 5 seconds, except in the case of clock-driven instruments.

(5) For clock-driven apparatus take three exposures: snap for prominences at beginning, 15 to 20 seconds during totality for corona, and snap for prominences at end of total phase.

Radio Telegraphy and the Eclipse of the Sun.

SINCE 1912 observations have been made from time to time on the effect of solar eclipses on wireless signals. Up to 1925, however, the data obtained from the observations made was untrustworthy and contradictory, the reason for this being that the observations depended on estimates by the ear of the intensity of signal strength. Apart also from the absence of accurate and suitable measuring apparatus, it is only in recent years that the mechanism of the propagation of waves round the earth has been understood to a sufficient extent to indicate the type of observation likely to yield positive results. The path of totality of the eclipse which took place on Jan. 24, 1925, crossed the United States, and the opportunity was then taken of arranging for a network of observing-stations on a comparatively large scale. At several of these stations galvanometer-recording methods were employed. During the same eclipse, observations of the field strength and direction of arrival of wireless signals transmitted from America were made in Great Britain. By that date also the theoretical work of Eccles and Larmor had provided a hypothesis of wave propagation by which the results obtained could be tested.

To understand the effect a solar eclipse is likely to have on wireless signals it is necessary to review briefly the manner by which it is now believed that electromagnetic waves are propagated through space. From any transmitting aerial part of the energy emitted is propagated horizontally along the surface of the ground and part is propagated in an upward direction into the atmosphere. The resistance of the earth has an absorbing action on the waves travelling over its surface. This absorption is least with long waves, and becomes very great in the case of what are known as ultra-short waves, that is, waves below, say, 100 metres. Owing to various cosmic influences, particularly radiation from the sun, the earth's atmosphere is ionised. During the daytime ionisation occurs at comparatively low levels, but with sunset recombination takes place in portions of the atmosphere where the gas pressure is fairly large, and by night, only the upper atmosphere at a height above 70 kilometres is left in an ionised state.

The effect of the ionisation of the atmosphere on electromagnetic waves has been shown by Eccles and Larmor to be twofold. First the electrons or ions present are set into vibration by the waves. As the electrons move they set up small electromagnetic waves out of phase with the original wave. The combination of the electric forces of these two waves causes the upper portions of the waves to appear to travel with a greater velocity than the lower portions, so that the wireless waves in the ionised medium are bent towards the earth. The amount of bending produced has been shown to depend on the intensity of ionisation and upon the square of the wave-length. Larmor has shown, however, that another effect of the ionisation present must be taken into account. This factor is the loss of energy due to collisions between electrons and gas molecules. This loss produces an absorbing effect on the waves passing through the medium, and in order that the effect may be small, the electrons must have a long mean free path; therefore the bending effect on the waves can only take place in the upper regions of the atmosphere. It would be expected on this theory that the absorption due to the ionisation in the atmosphere would be less with very short waves of high frequency than with longer waves, since the time between a collision of an electron and a molecule will be greater than the frequency of the wave.

The general result is that upward radiation from an aerial may be pictured as struggling upwards through the absorbing lower atmosphere until it reaches a level at which it is bent round the earth without loss, again enters the absorbing layers, and finally reaches the earth once more. At night the absorption will be less, since the ionisation due to sunlight in the lower levels will be absent. Thus in general, wireless waves are propagated to greater ranges at night except in the case of extremely short waves, less than, say, 16 metres, the frequency of which is so great that the absorbing action is small, and a considerable intensity of ionisation is necessary to bend them round the earth. Such very short waves will therefore travel better by day than by night. It will thus be seen that, at short distances, a wireless receiver will be affected chiefly by waves which are directly transmitted along the earth's surface or through the lowest levels of the atmosphere; at intermediate distances the received signal will be the resultant of the direct ground wave and a wave travelling by the upper atmosphere; while at very long distances the effect on the aerial will be solely due to waves travelling through the upper layers of the atmosphere.

It follows from the above that the general effect of a solar eclipse should be similar to that of a sudden and very rapid sunset, followed by a sunrise. As the moon's shadow sweeps through the atmosphere, a recombination of the ions present will take place, with the result that the agencies producing the bending and absorption of the waves become confused and unsettled. A short time later, however, the lower atmosphere becomes clear of ions and night conditions prevail until the shadow passes on. The effect on the intensity of wireless signals during the eclipse should therefore be first a decrease in the average intensity followed by an increase. Broadly speaking, this was the result generally obtained in the 1925 experiments. The relative and absolute amplitudes of the drop and rise in signal strength were found to depend, however, on the position of the transmitting and receiving stations to the path of the shadow and on the wave-length used in the observations.

It appeared to the Radio Research Board of the Department of Scientific and Industrial Research that it was desirable that every endeavour should be made to use the opportunity offered by the eclipse on June 29 next for carrying out further observations on its effect on radio telegraphy. After discussion with other interests involved, a programme of observations has been drawn up which it is hoped will yield useful results. A point brought to the notice of the Board by Dr. E. H. Rayner, of the National Physical Laboratory, which has not previously been taken into account in eclipse observations, is that, as the altitude of the sun is low, the line on the earth's surface vertically over which that portion of the ionised layer lies in which the bending of the wireless waves probably takes place, is about 100 miles to the south-east of the line of totality on ground level. In the experiments to be carried out this fact is being borne in mind. In one set of experiments which are to be carried out under the supervision of Prof. E. V. Appleton, observations will be made by photographic recording apparatus on wireless signals crossing the line of ground totality—transmitted from Newcastle and received at Liverpool. Similar simultaneous observations will be made on transmissions from a station to the south of the ground totality line and received at the Radio Research Station at Peterborough.

The object of the experiments is in particular to investigate the height at which the bending of the waves by the ionised layer takes place during the eclipse and to endeavour to note the changes in the height of this layer. The method to be used is that described by Prof. Appleton in his paper in the *Proceedings of the Royal Society* (vol. 109, A, p. 621, 1925), whereby the wave-length of the transmitting station is varied through a small known amount (for example, 5-10 metres) in a given time (for example, 10-30 seconds), and the height of the layer is calculated by counting the number of interference fringes produced by the interference of the ground and atmospheric rays. The number of fringes produced depends on the path difference between the rays. From this number a simple calculation gives the height at which the bending of the rays takes place. It has been possible to arrange for the necessary transmissions for these experiments by co-operation with the British Broadcasting Corporation.

In connexion with previous work of the Radio Research Board, long-wave signal-strength measuring apparatus has been developed by Mr. J. Hollingworth and installed at the Radio Research Station at Slough, at the University of Aberdeen, and at University College, Exeter. This apparatus will be employed for accurate signal-strength measurements on long-wave stations during the eclipse. The distance at which the ionisation of the atmosphere comes into play is greater in the case of long waves than with short waves. The necessary transmissions for observations on long waves are, accordingly, being arranged from continental stations under the auspices of the Union Radio-Télégraphique Scientifique Internationale. Long-wave intensity observations are also to be carried out with the apparatus developed by Prof. E. W. Marchant at the University of Liverpool.

Recent research has shown that the variable errors in radio direction-finding are due to the interaction of the magnetic fields of the ground and atmospheric waves. Under certain conditions these two forces give a resultant magnetic field not at right angles to the direction of the transmitter, and therefore an error in radio direction finding apparatus is produced. The direction of the magnetic field of the atmospheric wave depends, it is believed, on the ionisation of the upper atmosphere and on the relation of the direction of transmission to the magnetic field of the earth. To test this explanation of directional errors, observations are to be carried out by a network of direction-finding stations observing transmissions from the London and Manchester broadcasting stations. Finally, accurate records of the intensity of atmospherics on a selected wave-length and of the direction of arrival of individual atmospherics are to be made at the Radio Research Station, Slough, and in Scotland.

In addition to the above experiments, which are being carried out directly under the supervision of the Radio Research Board, the Radio Society of Great Britain is arranging for observations by its members on transmissions on 90 metres from a station at Caterham and on transmissions on 100 metres from a station in Iceland. Arrangements are also being made for transmissions on 23 metres and on a wave-length between 44 and 46 metres. These two latter stations will be situated one to the north and one to the south of the line of totality on the ionised layer.

A difficulty which presents itself in connexion with the present eclipse is that totality takes place so early in the morning that ordinary sunrise effects may not have entirely ceased and may mask to some extent the eclipse effects proper. In order to prevent the confusion of any eclipse effects with those due to other causes, all the observations proposed will be carried out on the mornings of the two days preceding the eclipse and on the two days following, in addition to the actual morning of the eclipse. The transmissions on which observations are made will extend for a period of two to four hours on each of these days.

How far the results of the experiments proposed will be valuable in checking present hypotheses of the propagation of wireless waves or in providing new information on this subject cannot, of course, be definitely stated beforehand.

O. F. B.

Astrophysical Eclipse Problems.

By Prof. H. Dingle.

If direct observation of the sun were our only means of investigating the form of our luminary, we should learn little more than that it is an incandescent rotating sphere. The spectroscope makes possible the beginnings of a structural analysis by revealing an absorption spectrum—that is, a continuous spectrum crossed by relatively dark lines. This assures us that, broadly speaking, the sun consists of two portions—an interior responsible for the continuous spectrum, and an atmosphere the constituents of which selectively absorb some of the light of the interior, each according to its kind. Whatever can be learnt from the continuous spectrum characterises the interior, while the study of the dark lines—the Fraunhofer lines—is the study of the atmosphere. In the ordinary solar spectrum, of course, both continuous and dark line spectra appear together. Neither can be obtained, in the first instance, apart from the other, so that the separate analysis of 'interior' and 'atmosphere' is greatly complicated. Some measure of success has nevertheless been achieved; for example, the effective temperature corresponding to the light from the interior has been determined from the continuous spectrum, while the spectroheliograph affords some knowledge of the distribution of a few types of atom in the solar atmosphere. But on the whole it may be said that the inevitable association, in the ordinary solar spectrum, of the atmospheric lines and the photospheric background is a great hindrance to the complete study of the respective regions of the sun—and particularly that of the atmosphere.

Observations of the sun's limb, where the atmosphere might be expected to appear alone and to show a bright line spectrum, reveal only that it is too thin (in angular measure) to do so. Even the spectroscopic method devised independently by Lockyer and Janssen in 1868 shows only the higher reaches of the atmosphere at the limb, and it was not until 1896 that it was finally established that there exists a bright line limb spectrum at all comparable with the Fraunhofer lines. Since that time the long-focus instruments at the Mount Wilson Observatory have given images of the sun with sufficient depth of atmosphere for the bright line spectrum to be observed, but when produced in this way the lines are still encumbered by the Fraunhofer spectrum, and the facilities afforded for detailed study of the solar atmosphere leave much to be desired. Only during a solar eclipse, when the photosphere is at least partly obscured by the moon, can a pure atmospheric spectrum be obtained, so that for our knowledge of the structure of the sun's atmosphere—the solar meteorology, as it may be called—we still rely mainly on eclipse observations.

Three aspects of the bright line, or 'flash' spectrum, are studied in modern eclipse research; namely, the wave-lengths of the lines, their relative intensities, and the distribution in the solar atmosphere of the atoms or ions responsible for them. It appears probable that the determination of wave-lengths will in future be attempted only by the method described below (p. 91) by Prof. Fowler, for which totality is not necessary. It need not, therefore, be referred to here except to point out its uses in the identification of the lines and the recognition of disturbing influences in the event of displacements being established with respect to terrestrial standards or the Fraunhofer spectrum. Two facts must be borne in mind in this connexion. First, the Fraunhofer spectrum is observed more or less radially, and the flash spectrum tangentially, so that there may be differences in the thickness and state of motion of the regions of the atmosphere observed; secondly, the lowest layers of the atmosphere can be observed only through an envelope of the higher layers, and any difference of wave-length at different levels will broaden the lines and possibly give rise to unsymmetrical reversals when the lines are examined microphotometrically.

The question of the relative intensities of the lines has greatly increased in importance with the development of modern spectroscopic theory. It is intimately bound up with the question of the distribution of atoms and ions in the sun's atmosphere; for the intensity of a spectrum line depends both on the number of atoms of the proper kind which are present, and on the physical conditions tending to make them emit that particular line. It is necessary, therefore, not only to compare the relative intensities of different lines, but to investigate also the variation in intensity of each line in different regions of the atmosphere. Since it is only the atmosphere at the limb which is being studied, this is equivalent to a determination of the variation of intensity along each line, supposing a radial or tangential slit to be employed.

This investigation is attended by considerable difficulties. Not only is there the complication already referred to (namely, that the ends of the lines representing the lowest levels may contain light from the higher levels also), but also the diffused light in the earth's atmosphere tends to fill the slit and make the distribution of light in the spectrum line differ from that in the corresponding regions of the sun's atmosphere. This effect is very pronounced in misty weather, and on such occasions, when a radial slit has been used, bright lines have been observed to extend even over the whole diameter of the dark moon. Objective prism spectrograms (*i.e.* spectrograms obtained by placing a prism before the object glass of an astronomical telescope, and using neither slit nor collimator) in which each 'line' is a crescent image of the region of the solar atmosphere emitting the corresponding wave-length, do not suffer from this defect, for the diffused light, entering the telescope from all directions, is simply spread over the photographic plate to produce an imperceptible fogging. In these spectra the lengths of the arcs measure the heights in the sun's atmosphere reached by the corresponding emitting sources, but irregularities in the moon's limb and other interfering agencies invest the results with a considerable amount of indefiniteness. All photographic methods of attacking this problem have to cope with the further difficulty of non-uniform sensitivity of the plates to light of different wave-lengths; thus, two lines of the same length in different parts of the spectrum do not necessarily arise from emitting sources similarly distributed in the sun's atmosphere. Results obtained from many eclipses will have to be carefully analysed and compared before trustworthy conclusions in any degree of completeness can be reached.

The beautiful photographs obtained by Merfield at the eclipse of January 1926 suggest that the method employed by him (it was in part proposed also by Lockyer in 1896, but clouds prevented the trial) might yield valuable results. It consists in photographing an objective prism flash spectrum on a plate moving uniformly at right angles to the direction of dispersion, immediately in front of the plate being a narrow slit, lying along the spectrum, so as to reduce the instantaneous image of each 'arc' practically to a point. The resulting spectrum then appears as a set of parallel lines of various lengths, and it is proposed to determine the heights reached by the corresponding emitting sources from a measurement of the rate of change of intensity along the lines. It remains to be seen what degree of success the method is capable of yielding when the actual determinations have been made.

When the general distribution of the various types of atom and ion in the solar atmosphere has been reliably determined, the application of recent spectrum theory will give much information concerning the physical conditions existing there. A particular investigation of this character is being undertaken on June 29, in which attempts will be made to determine the relative intensities in the chromosphere of the Ca^+ diffuse 'doublet' at λλ8498-8662 in the infra-red, and the bright counterparts of the well-known H and K Fraunhofer lines in the violet. The result should have considerable significance in connexion with the theory of the calcium chromosphere proposed by Milne. Photographs extending still further into the infra-red, up to about λ15,000, are also to be attempted.

These eclipse researches into the constitution of the sun's atmosphere are of great interest and importance, but they must always play second fiddle to the study of the corona, because it is only during a total eclipse of the sun that the corona can be observed at all. The investigations referred to above are greatly facilitated by the intrusion of the moon, but they could be carried out in some manner if the moon did not exist. (It must not be forgotten, however, how much the methods employed on the uneclipsed sun owe to knowledge gained originally from eclipse observations.) But if there were no moon, or if the moon were slightly farther from the earth than it is, we should not to this day suspect even the existence of the corona. It is obvious, therefore, that whatever else may be neglected at a total eclipse, all possible information must be obtained with regard to the corona.

Our absolute knowledge of the corona may be summed up very briefly. It is an intricate solar envelope the form of which varies with the phase of the sunspot period, while its light, which is partly polarised, consists of a combination, in varying proportions, of unknown bright lines, continuous spectrum, and Fraunhofer spectrum. Considering that the corona is observable, on the average, for at most about three minutes every two years or so, it is not surprising that our knowledge of it is so rudimentary. Single observations have no definitive value; they need confirmation at subsequent eclipses. In the case of the corona they have perhaps more often been contradicted, so that uncertainty exists whether the observations are at fault or whether the corona has changed. In these circumstances progress is necessarily slow, and many records must be accumulated before conviction can be reached.

A record, as complete as possible, of the form of the corona at each observable eclipse has been kept for some years, and must of course be continued indefinitely. In time this should reveal any obvious periodic changes of form or structure which may exist in addition to the already known relation with the sunspot period. The connexion between the corona and the solar prominences might also be elucidated from such a record. The difficulties, however, are enormous, for not only are there long gaps between successive photographs or drawings, but also at each eclipse the coronal light seen is at each point an unanalysable integration of light emitted along a chord of the coronal shell, and does not represent a simple plane section of the shell. The changes in the form of the corona appear to be slow. Attempts have been made to detect them by observing the same eclipse near sunrise and sunset, but the results are inconclusive. Further attempts are desirable. For such observations to be successful there must be convenient sites near the two ends of the belt of totality and the sun must be unclouded at both stations—a combination of circumstances which very rarely occurs.

The total light of the corona still awaits a satisfactory determination. It no doubt varies from one eclipse to another, and might be correlated with the sunspot period. Still more important, perhaps, is the law of variation of light with distance from the sun's limb. Several widely differing formulæ have been proposed, and here again there are probably changes from one eclipse to another. The heat radiation of the corona was measured by Abbot in 1908, but further determinations would be of much value. The very delicate apparatus designed by Callendar for use in the 1905 eclipse, which was spoilt by clouds, might give valuable results in this direction of research.

The spectrum of the corona and its connexion with the sunspot period are as yet very imperfectly understood. The portion of the light which gives a Fraunhofer spectrum comes from the middle and outer corona, and is undoubtedly reflected or scattered sunlight. Experiments on the amount and kind of polarisation of this light at different distances from the sun's limb are necessary to afford an insight into the mechanism of the reflection or scattering, and hence into the physical constitution of the corona. Such experiments have been made at many previous eclipses, but the difficulties of interpreting the results are so great that further investigations by the most trustworthy methods are necessary. The continuous spectrum of the inner corona may also be due to photospheric light, but there are reasons for thinking that it originates in the corona itself. Confirmation is difficult, but the evidence most obviously necessary is that of the curve of distribution of energy throughout the spectrum.

The line spectrum of the corona offers perhaps the largest field for investigation. None of its lines has yet been recognised in the laboratory, and its composition is very uncertain. Much progress has been made in disentangling it from the chromospheric spectrum, but finality has not yet been reached, and the faintness of the spectrum makes it almost certain that the present lists of lines are far from complete. Variations in the relative intensities of the lines at different eclipses suggest that it is a superposition of two or more spectra. Several attempts, on numerical as well as observational bases, have been made to classify the lines into groups, but the results so far are not consistent. The spectrophotometric measures initiated by the British expedition to Sumatra in January 1926 indicate a promising method of classification in terms of the variation of intensity along the lines. When such data have been obtained at a number of eclipses, accidental similarities can be eliminated and possibly definite conclusions arrived at.

The precise wave-lengths of the coronal lines are important for both laboratory identification and measurement of motions in the line of sight. There is so little agreement as yet between the various sets of measures available that further determinations with the highest possible degree of accuracy are of the greatest importance. It may be hoped that Prof. Fowler's experience this month with high-dispersion photographs of the 'flash' spectrum will show that the same method is practicable with the corona—at least so far as the brighter lines are concerned. The line spectrum of the corona appears to be relatively brighter at maximum than at minimum of the sunspot period, so that the coming eclipse should be favourable for the various investigations connected with it.

It will be realised that the outstanding astrophysical eclipse problems are 'many and various.' We may reasonably hope that, granted fair weather, our English eclipse will lead to important extensions of our knowledge of the sun.

Spectroscopic Observations during a Partial Eclipse of the Sun.

By Prof. A. Fowler, F.R.S.

It is common knowledge that the chromosphere and prominences which surround the visible surface of the sun cannot be seen in the telescope at ordinary times because they are less bright than the diffused light of the sky on which they are superposed. They can, however, be observed by combining the telescope and spectroscope in the manner discovered by Lockyer and Janssen in 1868. The spectroscope being adjusted on the bright red line of hydrogen (Hα), and an image of the sun being focussed tangentially to the slit, the diffused sky light is spread out into a continuous spectrum (crossed by dark lines) and is thereby so much reduced in intensity that the bright hydrogen line in the chromosphere, or from a prominence, becomes easily visible. To see the actual forms of the chromosphere and prominences, it is only necessary to open the slit rather wide.

Other bright lines besides Hα, including the yellow line of helium, D_3, and the hydrogen line Hβ, may be observed in the same manner, but they are not numerous when instruments of moderate size are employed. Spectroscopic observations with large telescopes at ordinary times, or with ordinary instruments during total eclipses, however, have shown that as the sun's edge is approached the bright line spectrum increases in complexity and finally exhibits a multitude of bright lines which originate in a region extending less than two seconds of arc above the photosphere, the apparent diameter of the sun being nearly two thousand seconds of arc.

When observations are made near the central line during a total eclipse, the spectrum of this shallow layer suddenly bursts into view at the beginning of totality, and almost as quickly disappears; it reappears for two or three seconds just before the end of totality, at the point of contact of the sun and moon. On account of its brief duration under these conditions, the spectrum of this shallow layer which surrounds the sun has been called the 'flash spectrum,' and the layer itself the 'flash stratum.' It is here that a large proportion of the absorption which produces the dark Fraunhofer lines of the ordinary solar spectrum takes place, and the flash stratum is accordingly also known as the 'reversing layer' of the sun.

Overlying the reversing layer, but not sharply divided from it, to a total height of about ten seconds of arc above the photosphere, is the chromosphere. This has not a smooth continuous surface, but is roughly serrated, and the prominences, which are sometimes very brilliant and reach to enormous heights, rise out of the chromosphere.

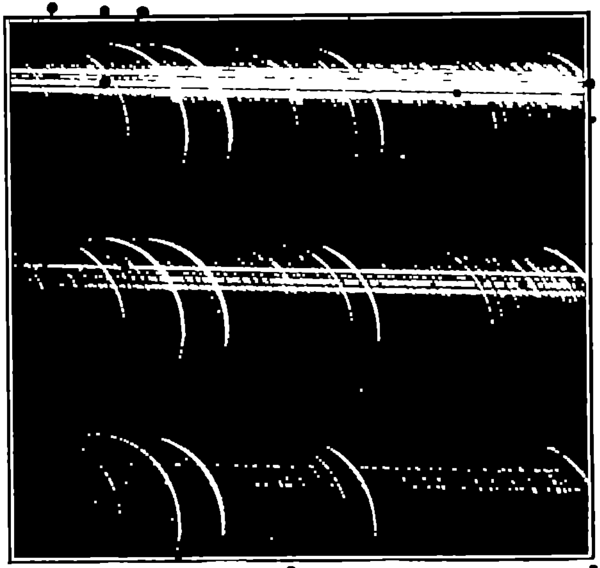

FIG 1 —Flash spectra: portion of the first large plate taken with a 6-in. prismatic camera in India, 1898 By Prof. A. Fowler.

On ordinary occasions, with telescopes of moderate size, it is not possible to observe the spectrum of the reversing layer, because of the 'boiling,' due to atmospheric tremors, which blends the bright lines from the thin stratum with the brighter spectrum of the edge of the sun's disc. Occasionally, however, there is a disturbance at some place near the sun's limb, and the reversing layer may then be so far elevated that a large number of bright lines can be differentiated from the photospheric spectrum. With the large instruments available at the Mount Wilson Observatory, bright lines have been photographed in large numbers without an eclipse, but even here the flash spectrum is somewhat confused by that of superposed sunlight.

It is during total eclipses of the sun that the flash spectrum can be most effectively observed. The reversing layer is then revealed for a brief time on a comparatively dark background, with no interference from the bright disc of the sun. Its spectrum has frequently been successfully photographed by the use of slit spectrographs of ordinary type, and by the use of prismatic cameras or slitless spectroscopes. With the latter form of spectrograph a spectrum taken near the beginning of totality consists of a succession of curved images of the portions of the chromosphere and reversing layer visible at the moment of exposure, each representing a spectrum line, and having a length depending on the height of the gas or vapour which produces it. The nature of such photographs will be gathered from Fig. 1, which reproduces a small part of a plate containing ten such spectra taken at intervals of about one second, beginning a few seconds before the commencement of totality in India in 1898. In these photographs the reversing layer is represented by the numerous short arcs which appear in the middle of each spectrum, and the chromosphere by the longer arcs, among which those of calcium H and K, hydrogen and helium are very conspicuous. The bright streaks of continuous spectrum originate from specks of the sun's disc which were visible through irregularities in the edge of the moon.

Such photographs bring out many important features of the bright line spectra, but for various reasons they do not yield wave-lengths of a high degree of accuracy. Excellent photographs have also been secured with slit spectrographs, but in observations during totality, the dispersive power which can be utilised is limited by the short duration of the phenomena.

In order to obtain an increased duration of the flash spectrum, Evershed, in the eclipse of 1900, selected a station near the edge of the zone of totality. In these circumstances it will easily be understood that the dark moon must glide tangentially with respect to one point on the sun, so that the flash spectrum can be effectively observed near that point for a considerably longer time than from a place near the central line. Thus, using a prismatic camera, Evershed succeeded in obtaining good photographs of the flash spectrum during a period of about half a minute, and the illumination of the sky throughout this period was sufficiently reduced to allow of the fainter lines being registered on the plates.

Observations of the large partial eclipse which was visible in England on April 17, 1912, indicated another means of observing the flash spectrum for a comparatively long time, and suggested that photographs might be taken with instruments of large dispersion, comparable with those used for the sun itself. This possibility is opened up by the fact that at the cusps of the partially eclipsed sun the flash and chromospheric layers project to a greater distance than their radial depths. This will readily be understood from the diagrammatic representation in Fig. 2.

At South Kensington the magnitude of the eclipse of 1912 at central phase was 0·92, and visual observations by Fowler showed that the flash spectrum could be effectively observed at the cusps during about thirty minutes. Some gain in visibility of the bright lines was first noted when the magnitude of the eclipse was 0·55, while the apparently complete flash spectrum was visible when the magnitude of the eclipse was 0·8 or greater (*Monthly Notices, R.A.S.*, 72, 538). Similar observations were made at Cambridge by Prof. Newall (*Monthly Notices, R.A.S.*, 72, 536).

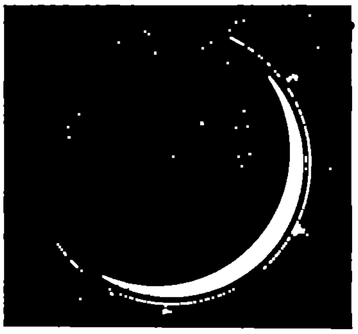
FIG. 2

In view of these observations, it seems possible to employ spectrographs of greater power than any hitherto used in eclipse work, and to impress comparison spectra for the accurate determination of wave-lengths. It may thus be hoped to obtain data for the investigation, among other things, of possible small displacements of the bright lines such as are already known in connexion with the Fraunhofer lines.

It was intended to make this experiment in Russia on Aug. 21, 1914, but owing to the outbreak of the War the expedition had to be abandoned, and the instruments were not returned to England until 1924. It is now planned to employ practically the same equipment during the eclipse of June 29 this year.

Although slightly better conditions might be obtained by the occupation of a station somewhat nearer the central line of eclipse, the instruments are being erected on the roof of the Imperial College of Science at South Kensington. The magnitude of the eclipse there at central phase will be 0·96, and the experience of 1912 indicates that this will be ample for the purpose in view. Any advantage likely to be gained by going farther north would, it is thought, not sufficiently compensate for the loss of the facilities afforded by the College laboratories and workshops. Prof. Sampson has also taken this view and will attempt similar work at the Royal Observatory, Edinburgh, where the greatest magnitude of the eclipse will be 0·98.

A large partial eclipse also provides a very favourable opportunity of investigating the spectrum of the sun near the limb. The observations at Mount Wilson have already shown that this spectrum differs very considerably from that given by the centre of the disc, but observations during a large partial eclipse may have the advantage that there will be no scattered light from the central parts of the disc superposed on the light emanating from near the sun's edge.

The spectrograph to be employed at South Kensington has a concave grating of 10 feet radius in an Eagle mounting, and will be adjusted for the second order spectrum so as to avoid undue astigmatism. An image of the sun about 2 inches in diameter will be formed in the plane of the slit by a 6-inch objective, which will receive light from a cœlostat after reflection from a second mirror. Adjustments are provided for maintaining the image of a cusp on the desired part of the slit, and it is expected that the exposures required will not be so long as to cover an undesirable range of solar latitude as the cusp changes its position on the sun. The requisite astronomical data for South Kensington have been specially computed by Dr. L. J. Comrie of the "Nautical Almanac" Office.

The Forms of the Solar Corona and their Origin.

By Dr. William J. S. Lockyer.

It is only during total solar eclipses, when the moon comes exactly between the earth and the sun, and cuts off all the brilliant light of the disc, that an outer solar atmosphere of an exquisite pearly hue known as the 'corona' is revealed. Without such eclipses, this atmosphere, even with the aid of any of the great and ingenious optical means available to-day, would still be unknown. The corona is of very considerable extent, far exceeding, in proportion to the size of the solar disc, that of our own in relation to the size of the earth.

It is well known that the form of the corona varies in shape and brilliancy very considerably. Sometimes the form is very irregular, the coronal matter being extensively distributed all round the solar disc, embracing both the solar poles and the equator. This form is termed 'polar,' 'irregular,' or 'maximum,' as coronal streamers are situated near the solar poles (Fig. 1).

On other occasions the polar regions are conspicuous by the complete absence of streamers, and in their place beautifully curved rifts or plumes are seen, the long streamers being restricted more to the equatorial regions. This type of corona is termed 'equatorial' or 'minimum,' and is sometimes referred to as of a 'wind-vane' form, as it resembles this object (Fig. 2).

Finally, there is a third and also very pronounced shape which is intermediate between the above two forms. This is termed the 'intermediate' type or 'square' corona. In this case the streamers are generally concentrated in mid-solar latitudes, leaving the poles and equator comparatively free from any large coronal extensions.

The use of the terms 'maximum' and 'minimum' with regard to the shape of the solar corona referred to the epochs of sunspot maximum and minimum, and it suggested a connexion with the periodic variation in the spotted area of the sun's surface. Until a few years ago, it was generally concluded that sunspots were therefore the origin of the coronal forms, and their waxing and waning was reflected in the changes of these forms.

Sunspots, however, do not appear at or anywhere near the solar poles; the highest latitude they ever attain is only 45°, and then they are only of very small area. On the other hand, large coronal streamers and prominent rays are sometimes situated in very high latitudes; in fact, at times they are very near or at the poles, and consequently quite outside the regions of spot activity.

Moreover, at the epochs of greatest spotted area, the mean latitude of spots is only about 18°; yet it is precisely at about those epochs that the coronal streamers appear at the poles, and the coronal forms are described as 'maximum' or 'polar.'

These facts suggested to me in 1903 that the prominences, which are not only very important factors in the mechanism of the solar atmosphere, but also can and do appear in all solar latitudes, might be directly responsible for these changes of form of the corona.

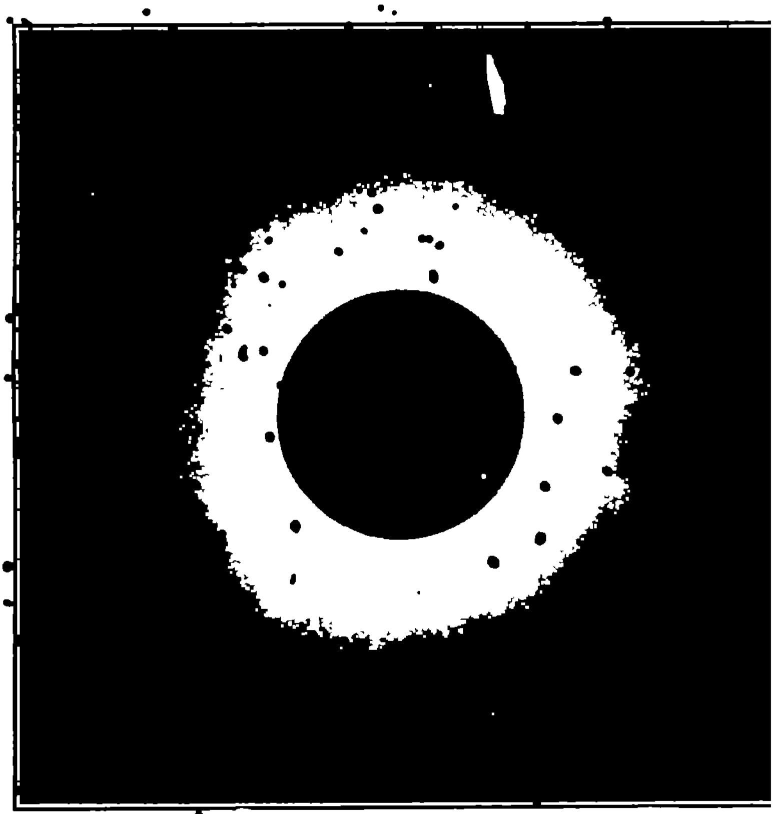

Fig. 1.—Solar corona, Aug. 30, 1905. Maximum type. Exposure 20 sec. By C. R. Davids
By permission of the Astronomer Royal

The crucial test resolved itself into demonstrating that the epochs of the occurrence of all those forms of the corona which exhibited streamers at or near the solar poles should be coincident with those epochs when prominences were known to be in very high latitudes. To do this it was necessary to study all the trustworthy data relating to the more modern records of solar activity.

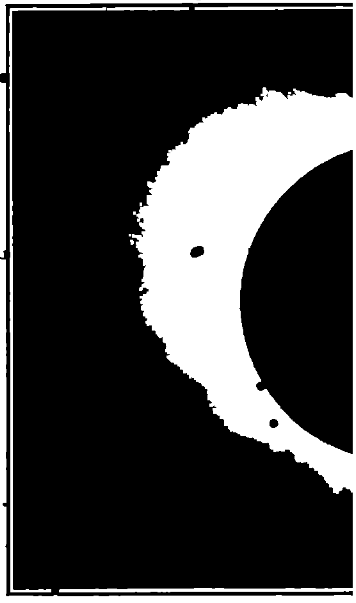

Fig. 2.—Solar corona, May 28, 1900. Mi

It is well known that the area or number of the spots on the sun varies from year to year, and that about every eleven years or so this number reaches a maximum value. This cyclical change of spotted area is shown at the top of Fig. 3. Sunspots are not formed on all parts of the solar

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nences, the accompanying diagram (Fig. 4) has been made showing this distribution for the years 1892, 1893, and 1894, the year 1893 being a year of sunspot maximum.

The central vertical line represents the solar equator or latitude 0°, and the black areas on each side of it indicate the areas of prominences for each of the three years (all drawn to the same scale) plotted for every five-degree zone of latitude on the scale given at the bottom for both north and south solar latitudes. It will be seen that prominences are distributed in all solar latitudes in these years, and in some cases are very pronounced in high solar latitudes in both hemispheres, as indicated by the pronounced peaks in the area curves.

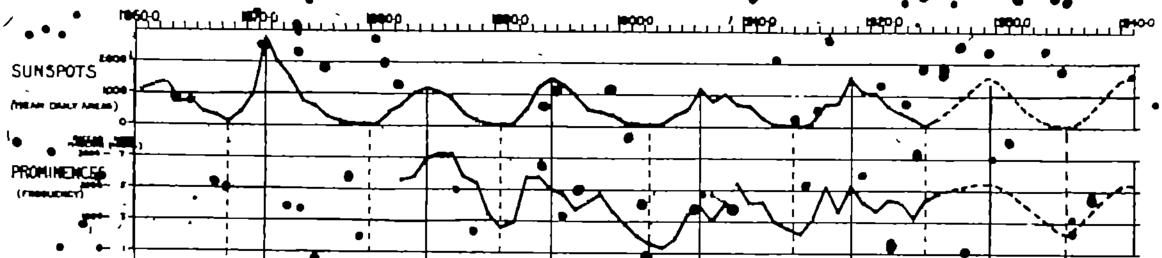

FIG. 3.—Diagram showing the relationship between the different forms of the corona and the latitudes of prominences.

The smaller white areas represent the areas of sunspots for the same years. They are all drawn to the same horizontal scale as regards latitude distribution as the prominences, but the vertical scale for their areas, while the same amongst themselves, is different from that of the prominences.

The diagram clearly shows, in the first place, the insignificant distribution of the spots in latitude compared with that of the prominences, and in the second place, that the zones of maximum spotted area, in these years about sunspot maximum, lie within 20° of latitude on either side of the equator.

A study of the fourth series of curves in Fig. 3 shows that when prominences are at their maximum frequency they occur in two zones, the mean yearly latitudes of which are about 70° and 25°. When they are fewest in number their mean yearly latitude is about 40°. This cyclical change of latitude from year to year is shown in the diagram.

Thus while the epochs of sunspot and prominence maxima are practically coincident, the spots at these times are most active in latitude about 18°, while prominences exhibit their greatest activity in about latitudes 70° and 25°.

Now from the prominence curves for both hemispheres it is quite easy at a glance to distinguish the years when these phenomena attain high latitudes, such as 60° or more. The question is, do these years pick up those cases in which the corona has been observed, and described as of 'polar,' 'irregular,' or 'maximum' type?

To answer this question easily, the various forms of the corona, as recorded by different eclipse observers since the time of routine prominence observations first began, namely, in the year 1872, are brought together at the bottom of Fig. 3. Thus, for example, all the forms termed 'polar' are placed in the first horizontal strip in their respective years of observation according to the time-scale indicated at the bottom. All those designated 'intermediate' and 'equatorial' are also placed in lower strips at their observed years. It is found that a curve can be drawn through them approximately resembling the sunspot and prominence curves at the top of the figure. Thus it is seen that the forms of the corona follow one another in the following sequence, namely, polar, intermediate, equatorial, intermediate, polar, etc.

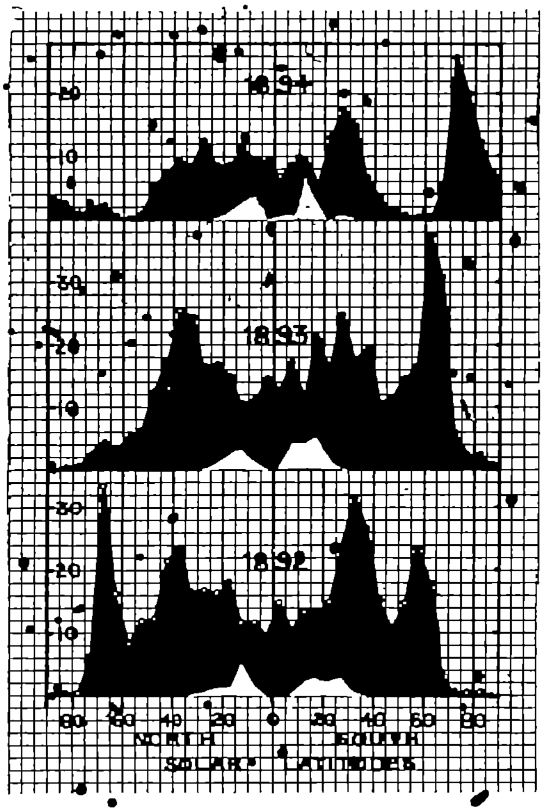

FIG. 4.—Diagram showing the distribution in latitude of prominences (dark areas) and sunspots (light areas) for the years 1892–94 (sunspot maximum 1893).

Comparing these coronal types with the curves immediately above them, it is fairly obvious that 'polar' forms are coincident with 'high latitude' prominences in every case except one, namely, in the year 1883. A re-examination of the prominence data for that year discloses the fact that their presence was recorded up to latitude 65° in the northern and 75° in the southern hemisphere; the yearly curve did not, however, exhibit distinctive peaks in either hemisphere at those latitudes, but only a gradual reduction in area from the prominent peaks in latitudes 25° north and south. There were therefore high latitude prominences in that year, so that 1883 is no longer an exception as expressed above.

It is important to point out further that there is no case of an 'equatorial' or 'intermediate' form of corona being recorded when the prominences were in high latitudes.

The deduction to be made is, therefore, that it is only when prominences are near the solar poles that coronal streamers will be found there. This fact points clearly to the conclusion that prominences are the prime factors in the formation of coronal streamers.

Limitations of space permit one only to mention here the fact that there is a mass of other evidence which can be brought to bear to show the close association of prominences with coronal forms, as, for example, the arch-forms of coronal matter so often recorded as being directly situated over large prominences, in spite of the fact that the material of which prominences are formed is quite distinct from coronal matter.

A more detailed study of the diagram shows that while prominences near the solar poles are responsible for the 'polar' or 'irregular' types of the corona, the 'intermediate' forms owe their origin to the presence of two zones of prominences, and the 'equatorial' forms to one zone in each hemisphere.

The rhythmic nature of all the curves, as shown by the continuous lines, suggests that they can be continued for a few years without any great error. This has been done in Fig. 3 by means of broken lines[1] up to the year 1940, and below them are forecast the various forms of the corona which may be expected in future eclipses up to that year, based principally on the probable prominence curves. The corona of the present year should therefore be 'polar' or 'irregular,' corresponding to a very disturbed state of the sun's atmosphere. It should thus be irregular in form, devoid of pronounced polar rifts, and should be very bright. It may exhibit long streamers in any solar latitude. Its brilliancy will probably prevent any but the brightest stars from being seen, but on the other hand it lends itself very favourably to special studies of its composition by means of the spectroscope.

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[1] There have just been published the latitudes of the mean areas of prominences for the first half of the year 1926. This shows that the zones of maximum area lie at latitudes 40° and 70° in the northern and 38° and 60° in the southern hemisphere, thus closely endorsing the points forecast in Fig. 3 for that year.

kindly lent by Mr. Worthington, will be used. This gives an image of the sun 5 inches in diameter. There is only time for one exposure of approximately 20 seconds.

(2) With a spectroscope of Littrow type, using a prism of 40° angle and 7 inches in height and a lens of 1½ ft. focus, the spectrum of the chromosphere in the red and infra-red will be photographed. Plates dyed with dicyanin will be used, and the spectrum will extend from the magnesium triplet in the green well into the infra-red.

(3) Prof. Milne has shown the importance of a photometric comparison of the H and K lines in the chromosphere; that is, the doublet $1^2S - 1^2P$ of ionised calcium, with the calcium lines at λ8498, 8542, and 8662; that is, the doublet $1^2D - 1^2P$ with its satellite. A spectroscope of reflecting Littrow type has been arranged to give these lines on the same plate. Neocyanin plates recently introduced by the Kodak Company will be employed. By the use of a coarse grating on the solar spectrum the intensity scale will be determined for different parts of the spectrum.

The times of beginning and end of totality will be observed with a direct-vision spectroscope on a 3-inch telescope.

University of Oxford.

The expedition to observe the eclipse at Southport, on the cordial invitation of the Mayor and Corporation, will be a joint expedition from the University and Radcliffe Observatories, Oxford, arranged by Prof. H. H. Turner and Dr. H. Knox-Shaw in collaboration.

The astrographic object-glass of the University Observatory, fitted to a temporary mounting used previously in Egypt in 1905, and pointed to the 16-inch cœlostat, recently purchased from the Royal Society, will be used to take two or three photographs of the corona. (The purchase of the cœlostat, and its renovation, were rendered possible by timely grant from the trustees of Lord Leigh's Fund.) In addition, two photographs will be taken in light polarised in planes at right angles by means of reflection from plane glass plates blackened on the back: the lenses are the similar components which made up the Abney lens used in many eclipse expeditions, and the reflecting plates will be placed near and within the focus. These two cameras will be mounted equatorially.

During a preliminary visit last January, when the kind help and advice of Mr. C. Davidson, of the Royal Observatory, Greenwich, were available, the site for the observations was fixed in the grounds of King George V. School, on the invitation of the headmaster, Mr. G. A. Millward, who has also extended his hospitality to 100 boys who will come from London under the care of the *Daily News*.

Stonyhurst College.

At Stonyhurst College arrangements are being made by Father O'Connor, director of the Observatory there, to take direct photographs of the corona with the 4-inch coronagraph lens belonging to the Royal Irish Academy, of 19 ft. focal length, a 6-inch Dallmeyer portrait lens of about 30 inches focal length, and a Dallmeyer telephoto lens.

An attempt will be made to photograph the corona with the 15-inch equatorial, using a green screen with maximum transparency at λ5300.

Flash spectra, as far into the red as possible, with the 19-ft. lens used as a prismatic camera, will also be attempted.

With the Hilger spectrograph, work will be carried out on the cusps before and after totality.

Quick runs on the magnetographs, and meteorological observations during the course of the eclipse, will complete the Stonyhurst official programme.

Solar Physics Observatory, Cambridge.

The altitude of the sun will not exceed 13° in any site in England at the time of the total phase, and accordingly the conditions in Norway were investigated. It was found that the altitude will be nearly twice as great in Hallingdal and the neighbouring valleys, and the local conditions thereabouts were examined. Prof. Newall and Mr. Carroll went over to Norway in September for three days, and had the great advantage of enlisting the kind help of Prof. V. Bjerknes, who met them at Aal (Hallingdal) on the railway between Bergen and Oslo. Here, after considerable exploration, a site was found in all respects convenient, though, as had been anticipated, the difficulty in that rocky and wooded region was to find a level site which was not already occupied by a house or a farmstead.

The observations which will be aimed at are the following:

Spectroscopic observations of the chromosphere in the ultra-violet (Prof. Newall). Spectroscopic observations of the red calcium lines in the chromosphere, high dispersion, and of both red and violet calcium lines in the chromosphere, low dispersion (Mr. Carroll and Mr. Stratton). Spectroscopic observations with objective grating and moving photographic plate (Mr. Butler). Photometric work in connexion with each of the above. Interferometer observations of the corona (Prof. C. Bryant). Large-scale coronagraph photographs (Mr. W. M. Smart). Polariscopic observations of the corona (Prof. Newall).

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photographs of the corona the programme includes spectroscopic observation of the chromosphere in the ultra-violet and the infra-red, with special application to the relative intensities of the red calcium triplet and of H and K. The intensities of lines at different heights will also be studied. Spectrophotometric work will figure largely in the programme, and there will also be polariscopic observations and interferometer photographs of the corona.

The American expeditions are all, except that of President Morehouse, to be stationed in Scandinavia. Prof. H. T. Stetson, of Harvard Observatory, and Mr. Weld Arnold, will be doing photometric work on the total brightness of the corona at Fagernäs, where Prof. S. A. Mitchell, of the Leander McCormick Observatory, will also be stationed. Farther north, possibly near Gellivare, will be the Dutch expedition, including Dr. Minnaert, with the spectrophotometric programme which they were prevented by clouds from carrying out in Sumatra last year. Dr. Luyten will accompany this party. In addition to Prof. Stetson's photometer and the Dutch instruments, it is understood that Dr. Anderson's eclipse spectrograph, which was also blocked by bad observing conditions in Sumatra, will again be brought into use, in the hands of Dr. S. Rosseland. Finally, an Italian expedition under Prof. Horn d'Arturo may be stationed in Norway; and it may be assumed that there will be several Scandinavian expeditions and German expeditions in Scandinavia also. Details of their plans have not come to hand.

Nowhere along the track can it be said that weather prospects are very good. On the other hand, they are not so bad that we may not expect fairly confidently results of value from some of the many expeditions that will be observing the eclipse.

Observing Parties and Stations.

The Norman Lockyer Observatory.

DR. W. J. S. LOCKYER, director of the Norman Lockyer Observatory, informs us that the expedition from the Observatory will occupy a site on the eastward and adjoining side of a good road connecting Richmond with Gilling village, and distant one mile from the market place of the former town. It is on the Marquess of Zetland's estate, and he has very kindly given permission for the Observatory's party to take up its position there. The site is situated on a 600-foot contour line, and looking away from it towards the north, through the east and to the south, the ground falls away sharply at first and gradually afterwards. In fact, there is no land reaching anywhere near 600 feet within twenty miles of a line drawn due east and twenty-five miles a little north of east.

The programme of work to be attempted at Richmond is to secure large- and small-scale photographs of the corona, chromosphere, and prominences, and also a photograph of the spectrum of the corona.

The conditions of the eclipse are not sufficiently favourable to warrant the transport of a large spectrograph for photographing the chromosphere at second and third contacts. As such photographs can be obtained at stations where the partial phase is very large, arrangements have been made to accomplish this at the Sidmouth Observatory, where a large spectrograph is available.

Time determinations of the contacts will also be attempted, use being made of the broadcast time signals for checking the rate of the chronometer. The large-scale photographs of the corona will be taken with a camera the lens aperture of which is 6 inches, having a focal length of 31·5 feet, giving a solar image 3·3 inches in diameter. This instrument will be rigidly oriented to the eclipsed sun, the photographic plate only being moved by mechanism. One exposure only will be made.

Two smaller coronagraphs will in addition be mechanically driven, one having a 6-inch aperture and 4 feet focal length and mounted equatorially, and another a 3¼ inch Dallmeyer rectilinear lens of 15 inch focal length mounted on a 12-inch siderostat. One plate will be exposed in the latter and two or more in the former.

Four or more other coronagraphs from 4 inches aperture or less, including a Zeiss triplet aeroplane lens working at f 4·8 and an Aldis triplet aeroplane lens working at f 5·6, will be fixed in position, and two or more plates will be exposed in each, with exposures of two seconds or less.

The large-scale photographs of the chromosphere and prominences will be taken with a 30-foot coronagraph, giving an image of about 3 inches. This instrument will be fixed in the direction of the eclipsed sun, and the exposures given will be very short. Altogether about eight exposures will be attempted.

To secure the spectrum of the corona on a small scale, a Thorp transparent grating mounted in front of a Zeiss triplet aeroplane lens working at f 4·8 will be used. This instrument is mounted on the upper end of the polar axis of a 12-inch siderostat and is clock-driven. One exposure only will be made of the coronal spectrum in the first order of the grating.

The party from the Norman Lockyer Observatory will consist of Lieut.-Col. Sir Francis McClean, Capt. W. N. McClean, and Dr. W. J. S. Lockyer, but much additional volunteer assistance will also be available to manipulate several of the smaller instruments and undertake other observations.

Royal Observatory, Greenwich.

The headmaster of Giggleswick School has kindly placed a field at the disposal of the Greenwich expedition. The observing party will consist of the Astronomer Royal, Dr. Jackson, Mr. Davidson, Mr. Melotte, and Mr. Woodman. Three different observations will be attempted.

(1) A large-scale photograph of the corona will be taken. For this a 6-inch lens of 45 ft. focus,